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THE FUEL ECONOMIZER

ITS FINANCIAL AND ENGINEERING ADVANTAGES

BY CARL S. DOW

IN general it may be said that a steam power plant must contain boilers, engines or turbines, and a pump or injector; these being necessary to the production of steam power. But though such apparatus as superheaters, condensers, feed-water heaters and fuel economizers are not absolutely necessary, they are sometimes added to lessen the cost of power. Their adoption or rejection depends more upon the conditions which make savings possible by these devices than upon their engineering advantages. In short, the financial consideration is the controlling element, but at the same time the engineering advantages are not absent.

Chimney Loss

While the fact that much heat escapes from the ordinary power plant chimney is well known, it is not so often realized that the loss without an economizer, is as high as 25 per cent, or that the loss is greater than all the boiler and furnace losses combined. These few words show wherein lies the great opportunity for saving money.

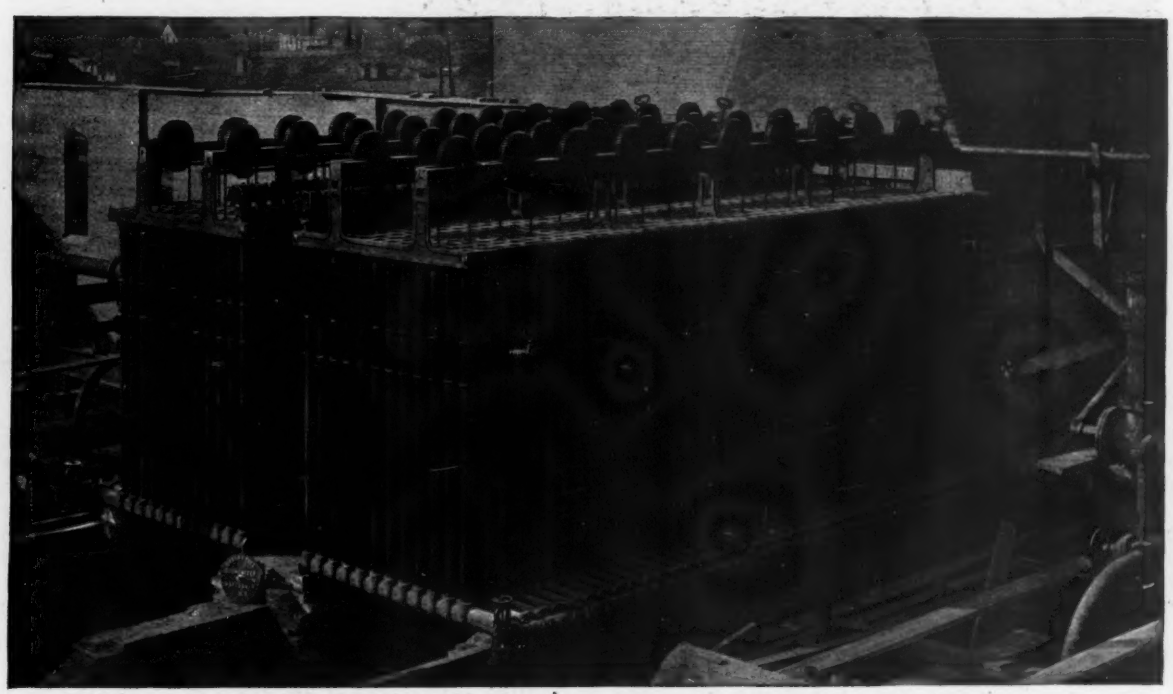


FIG. I. THE GREEN FUEL ECONOMIZER IN PLACE

There are 3 ways of reducing the chimney loss: first, by extending the boiler heating surface so that more heat will be absorbed in steam making; second, by the use of a superheater; and third, by the installation of a fuel economizer. The extension of boiler

heating surface cannot be carried very far, for it soon reaches a limit imposed by the steam pressure carried; for instance, steam at 150 lbs. has a temperature of 365 deg. F., and under such conditions the waste gases cannot be cooled below about 400 deg. The same is true of a superheater, so much so that it is customary to place superheaters in the first pass of a water-tube boiler so that they will be more effective than if in contact with gas that has had its temperature reduced somewhat by the boiler. When so placed the apparatus does duty as a superheater, but does not recover waste heat.

Function of Economizer

The economizer acts as a feed-water heater not as a steam generator, therefore there is a transfer of heat even when the temperature of the waste gas is less than that of the steam. The economizer seems to be the best means of recovering the waste heat, but as has been stated, an economizer is not often installed except when its financial benefits have been demonstrated.

Savings or profits resulting from the use of an economizer may be divided into 2 classes: First, the direct, which is the money value of the heat and labor saved above the interest on the investment and the cost of upkeep; and second, the indirect, which is the cost of increased boiler capacity (if the same amount of fuel is used) and the money value of the benefits to other apparatus.

Even before the apparatus is installed the amount of heat utilized by an economizer can be closely calculated, and this heat is equivalent to a certain amount of coal. The calculation is made by knowing some conditions and assuming that the economizer will bring about certain other conditions, but as the assumptions are derived from such dependable engineering knowledge they are almost as reliable as facts.

Saving By Heating

If a rough estimate of the saving in coal is sufficient, it may be taken as one per cent for every 11 deg. F. that the temperature of the feed water is raised by the economizer. Thus if the economizer heats the feed 110 deg., the saving would approximate 10 per cent. This is only an approximation, for one per cent saving has been had for about every 8 deg. rise, while on the other hand one per cent saving has in some cases required more than 11 deg. increase.

A satisfactory determination of the probable saving is a problem to be worked out for each set of conditions. The temperature of the waste gas leaving the boiler, the steam pressure carried, and the temperature of the water entering the economizer are 3 very important factors. Evidently the heat available for the economizer is greater when the gas leaves the boiler at a high temperature; this is the reason why an economizer shows so much saving with high-pressure steam and with boilers forced high above rating.

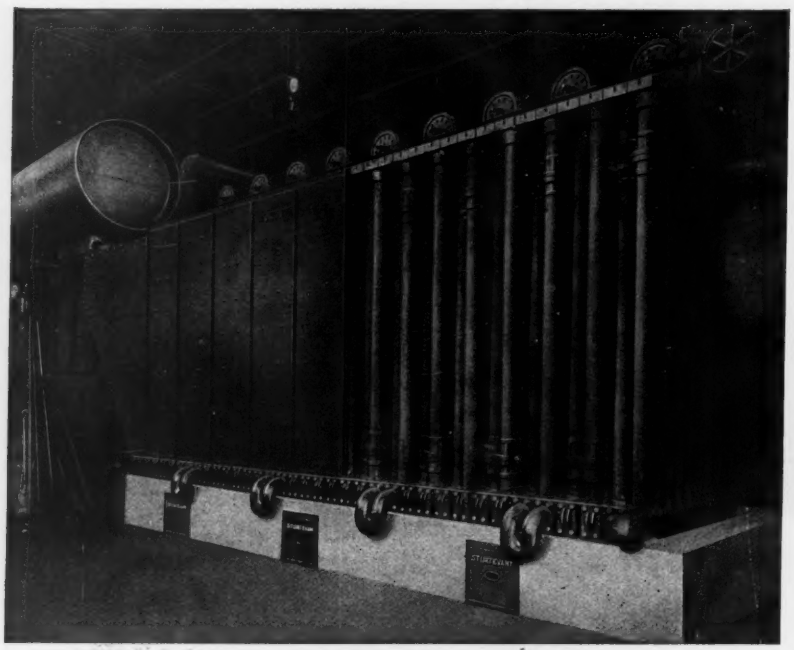


FIG. 2. STURTEVANT ECONOMIZER PARTLY ENCASED

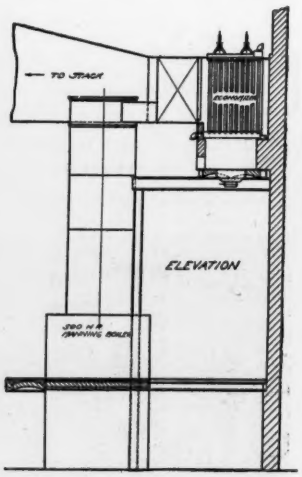


FIG. 3. ARRANGEMENT OF ECONOMIZER WITH VERTICAL BOILER

Heat available also depends upon the temperature of the feed water, for the economizer cannot reduce the gas to a temperature below that of the entering feed water, in fact the gas will have a temperature about 50 deg. above the feed. The steam pressure carried limits the temperature to which the feed can be heated; if the steam pressure is only about 100 lb. the water in the economizer cannot get above about 337 deg., otherwise steam will form in the economizer.

Available Heat

With gas leaving at 600 deg. and feed water entering at 210 deg., for every pound of gas there will be available for the economizer only $600 - 210 \times 0.23 = 89.7$ B. t. u., assuming the specific heat of the gas to be 0.23. If the gas could be cooled to 60 deg., $600 - 60 \times 0.23 = 124.2$ B. t. u. would be available. In practice these figures cannot be realized, not even the 89.7 for the gas cannot be cooled to so low a temperature, especially in a chimney installation. The greatest possible saving in fuel under these conditions would be 12.5 per cent, for the total heat in 1 lb. of water raised

from 210 deg. to steam at 100 lb. pressure is 1007 B. t. u. and the feed water is heated through 337 — 210 = 127 deg., and $\frac{127}{1007} = 0.125$.

Again the saving will depend upon the size of the economizer relative to the weight and temperature of the waste gas and of feed water. It is evident that the greatest saving, theoretically, would occur if no steam feed-water heater were used so that water at 60 deg. could be turned into the economizer and raised in temperature just as high as the heat in the gases could do it, which limit would be imposed by the heat units in the gas, or by the temperature corresponding to the steam pressure. But the economizer would then be very large, so large as to be objectionable because of excessive first cost. Also it would interpose between boiler and chimney so much resistance that the draft might be insufficient, necessitating the expense of mechanical-draft apparatus. A third objection would be the sweating and consequent corrosion of the economizer pipes caused by the moisture in the gas being deposited when the gas strikes the cool pipes; this last objection can be quite readily removed by passing some of the hot water to the entering end, thereby tempering the cold water.

Size Economizer Needed

It has been found from years of experience, that the most practicable size for an economizer with average conditions is one that will reduce the temperature of the waste gas about twice as many degrees as the temperature of the feed water is increased. As this rise of feed-water temperature is usually in the neighborhood of 100 to 125 deg., the saving in fuel is ordinarily about 10 per cent, a figure which can be increased slightly if the draft will admit of a larger economizer. But 10 per cent of fuel is not the net saving, because the interest on the investment, taxes, insurance, depreciation, and cost of operation must be deducted. What the net saving will be can easily be worked out for any given conditions.

Example for Illustration

Let us assume a boiler plant of 3,000 horsepower, using coal costing $40,000 a year. Of course the cost of coal varies with the kind and locality and the fuel bill depends upon the amount needed per boiler horsepower. The above cost is based on average practice, the coal per horsepower conforming to the figures published in Bulletin No. 373 of the U. S. Geological Survey, in which are given average weights per horsepower-hour for coals from 18 states. The table shows that over 4 lb. is usually required. As an economizer of suitable size would probably save at least 10 per cent, or $4,000. The apparatus would cost about $12,000. Assuming no additional expense for labor, the net saving would be about as follows:

Interest 5% of $12,000	$600
Depreciation 5% of $12,000	600
Maintenance 1% of $12,000	120
Insurance and taxes 2% of $12,000	240
	$1,560

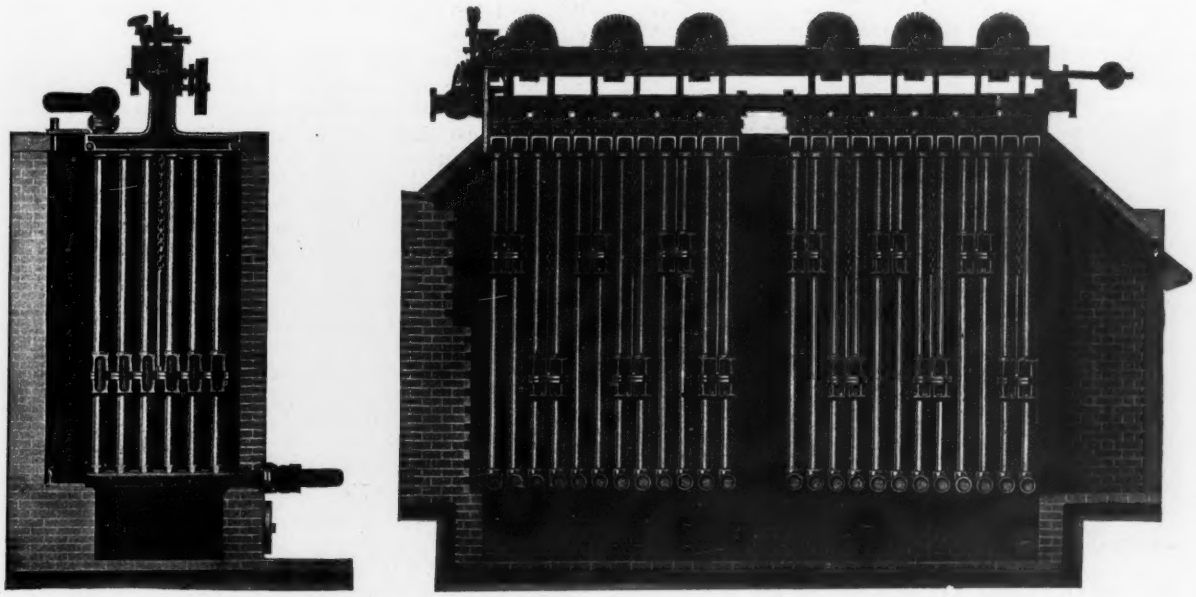


FIG. 4. SECTIONS LENGTHWISE AND ENDWISE OF GREEN ECONOMIZER

The net saving would then be $4000 — $1560 = $2440. This is an excellent return on the money invested, over 20 per cent. In an actual case, however, the saving would be even greater, for in addition to the fuel saved by the recovery of waste heat, there would be a saving due to better combustion, for with the burning of less fuel would probably come more nearly perfect combustion.

Actual Saving

This is illustrated by a test made by F. W. Dean. Computed from the temperatures of feed water with and without an economizer, the saving in fuel was a little over 10 per cent. When the results of the test were determined it was found from the evaporation figures that the saving was actually 13.84 per cent, or practically 3 per cent more than calculated.

The above discussion assumes that the output remains the same as before installing an economizer, the object being to save fuel. But suppose the original quantity of coal is burned and an economizer is

added to increase the output. The increase in capacity and the cost of the larger amount of steam can be calculated satisfactorily only when all conditions are known and the actual size of the economizer determined, for the net cost of the economizer effect is dependent upon the first cost of the apparatus.

Suppose, that in our 3000-horsepower plant the $40,000 worth of coal is burned just the same. The fuel cost of 1 horsepower per year would be $13.33. It is reasonable to assume that an economizer of 1100 pipes would be installed, costing about $13,200. The economizer heating surface would measure about 13,750 sq. ft., and under usual conditions 1 sq. ft. will transmit 750 B. t. u. per hour; or a total of 10, 312, 500 B. t. u. which equal practically 312 boiler horsepower. The increased capacity would then cost $312 \times \$13.33 = \$4,160$ (nearly) per year; thus the investment of $13,200 in an economizer would return power worth $4,160, or over 31 per cent; but from this must be deducted the interest on the investment, the depreciation, the cost of maintenance, taxes, insurance and operation.

Other Benefits

The calculation of the money value of the benefits to other apparatus is exceedingly difficult if not impossible. Perhaps it is better to consider the benefits from an engineering viewpoint, rather than financial, since anything that will prolong the life of apparatus or facilitate the operation of the machinery is an engineering advantage.

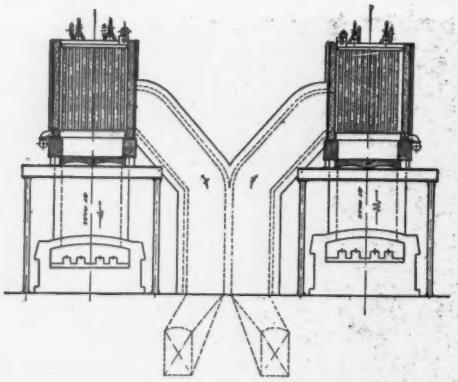


FIG. 5. ECONOMIZER USED WITH BILLET FURNACE IN STEEL WORKS

Of first importance is the feeding of hot water. Every engineer and fireman knows that hot feed water reduces the strains resulting from contraction, minimizing the number of loose joints, and consequent leakage, costly repairs, etc. It should be remembered that a steam heater seldom increases the temperature of the water to over 210 deg. F., while the economizer can be made to heat it almost to the boiling point, say 350 deg.

Again, water so heated deposits a considerable portion of its impurity, so that, with an economizer, the amount of scale is much less, a condition contributing to greater economy because of better heat transmission and less repair and cleaning expense.

The economizer filled with hot water acts as an accumulator, or balance wheel. Since each pipe holds about 60 lb. of water, there is in each pipe of this reservoir a supply of hot water sufficient for 2 horsepower-hours. As it is customary to use an economizer pipe for about each 2.5 horsepower, the storage capacity is sufficient for nearly an hour. In the average central station, whether for railway or lighting service, the peak load draws heavily on the boilers, but when this great supply of hot water is at hand the boilers need not be forced much above normal, for it must be remembered that to heat the water to the high temperature requires about ¼ as much heat as to raise its temperature to the boiling point and then convert it into steam. In other words, the stored water is ready to enter the boilers with about 25 per cent of the work of converting it into steam already done upon it.

Heat for Auxiliary Work

While the chief use of an economizer is to heat water for boilers, the apparatus often heats water for other purposes. Heat that otherwise would be wasted can be made to heat water for laundries, public institutions, hotels, paper mills, textile mills, tanneries, etc.

The water may also be used in coils and radiators for heating buildings, the heat leaving in the exhaust of gas engines furnishing an excellent opportunity for doing this. Doubtless as large gas engines become more common, especially those using producer gas, this will be an important application of the economizer.

Heat from Other Than Boilers

The source of waste heat is not restricted to steam boilers, nor yet to gas engines. An economizer was recently installed for the utilization of waste heat from billet furnaces in a steel works. It is used for heating the feed water for boilers which are not operated continuously even though the billet heating furnaces are never shut down except because of accident. While the furnaces are in operation there may or may not be boilers to use the water heated by the gas. The 2 economizers in this installation have a total of 1040 pipes, giving a heating surface of nearly 13,000 sq. ft. and heat 150,000 lb. of water per hour, the rise in temperature being equal to 100 deg. when producer gas is used, and 70 deg. when the furnaces are operated on natural gas.

CORRECTION NOTE

In the table on Page 466 of the August issue, for the allowable load on staybolts the diameter at the bottom of the thread for a 1-in. outside diameter should be 0.8557, for a 1 1-16-in. should be 0.9182, and for 1⅛-in. should be 0.9807. The load allowed on the 1⅛-in. bolt is also incorrect. At 6,500 lb. it should be 4,908 lb. instead of 5,558.

FOR SOLDERING GLASS TOGETHER use a metal alloy made up of 95 parts tin and 5 parts zinc which has a melting point of 425 deg. F. In order to solder the glass it must first be heated carefully to the above temperature and the alloy then spread on the glass by means of a soldering iron. When cool it will be attached firmly to the glass.

IN SIBERIA the temperature is so low that except for a few weeks in summer the people buy their milk frozen. For convenience in carrying it is frozen around a stick which forms a handle and the man leaves 1 or 2 chunks as may be ordered. The babies cry for a "bite of milk" and it is the milk that sometimes gets broken not the pitcher.

HEATING SURFACE of the tubes of a boiler is found by multiplying the total tube length in feet by 0.523 for 2-in. tubes, 0.654 for 2.5-in., 0.785 for 3-in., 0.916 for 3.5-in. and 1.047 for 4-in.

NEW POWER PLANT OF THE L. S. STARRETT CO.

THIS recently completed power plant at Athol, Mass., designed by Charles T. Main for the above company, comprises a boiler room and coal pocket in one building and the engine, generating, condensing, and feed water heating equipment in another. Between these buildings is a small pond, the level being maintained by a concrete dam which practically connects the 2 portions of the power plant. Through the dam is a tunnel, 170 ft. in length, which serves as a duct for carrying both steam and water piping, the steam being carried 400 ft. from the boilers to the engines.

The boiler room and coal pocket occupy a building triangular in shape measuring approximately 220 by

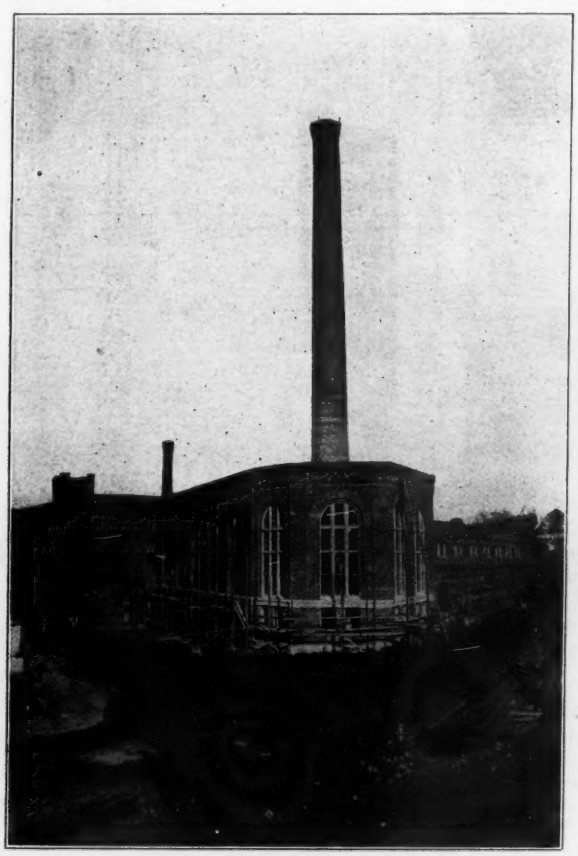


FIG. I. NEW BOILER HOUSE AND COAL POCKET OF THE L. S. STARRETT CO.

150 by 115 ft., with the boiler room extending across the end, about 47 ft. in width with a clear height of about 35 ft. The coal pocket occupies the rest of the building with the exception of the space required for the feed and fire pumps, feed-water well and chimney.

Boiler Room

The boiler equipment consists of 4 Babcock and Wilcox 500-hp. boilers in batteries of 2 with sufficient room for an extra battery. The chimney is of the Custodis type 8 ft. inside diameter with air space and has an outside diameter of 16 ft. 2 in. at the base; it is 175 ft. high from the boiler room floor. Two 24 by 8 by 12-in. Warren duplex outside plunger pumps fitted with a 5-in. joint discharge pipe, force the boiler feed water through the tunnel to the engine rooms and thence through 2 1200-hp. Whitlock primary heaters, and back to the boilers. These pumps draw their water from the well which is fed from the pond through a 24-in. pipe fitted with a sluice gate operated from the well room floor. The fire pumps are also supplied from this well. When necessary water may be drawn from the city mains at 120 lb. pressure.

The Coal Pocket

This is one of the unique features of the plant. In plan it is triangular, being 150 by 109 by 109 ft. and about 30 ft. high. The walls are of brick, within which is built a concrete steel shell or lining, which relieves the former of the pressure of the coal, and at the same time serves as a protection for the brick. This lining is built directly against the brick walls, except at one corner, thus saving the cost of form work on the outer side.

The brick walls are 12 in. thick with integral pilasters 20 in. thick; the concrete steel lining is carried up

FIG. 5. INTERIOR OF CONCRETE COAL POCKET

20 ft. Two 15-in. by 33 lb. channels back to back. spaced about 23 ft. apart and imbedded in the concrete, except on the boiler room side, connect with the longitudinal and transverse channel braces overhead, thus binding the parts subjected to the coal pressure firmly together.

On the boiler room side of the coal pocket the above mentioned vertical channels are set into the brick walls, and between these are vertical I beams varying in size from 7-in., 15 lbs., to 12-in., 31.5 lb. Between the latter are concrete slabs 5.5 in. thick, reinforced with both horizontal and vertical steel wires. For a distance of 6 ft. above the floor the horizontal reinforcing is of No. 0 wire, 4 in. on centers, and the vertical reinforcing of No. 6 wire spaced 12 in. Above this for a distance of 8 ft. are No. 5 horizontal wires and No. 8 vertical wires spaced respectively 3 and 12 in. on centers; this reinforcing metal is welded at its intersections. The concrete around the wall channels and I beams is held in place by metal lath reinforcing. All steel work is protected by at least 2 in. of concrete.

Two rows of steel columns spaced 18 ft. apart in

a transverse direction, and 23 ft. 6 in. apart longitudinally, connect with the overhead channel braces and support the longitudinal roof beams. These columns, of square section, are made up of angles latticed to form an I beam section and are encased in concrete up to a height of 15 ft.; at the corners of each column the concrete is reinforced by steel rods. Above the 15-ft. level the steel is exposed for a distance of about 5 ft., at which level the columns connect with the longitudinal and transverse channel braces at their intersection.

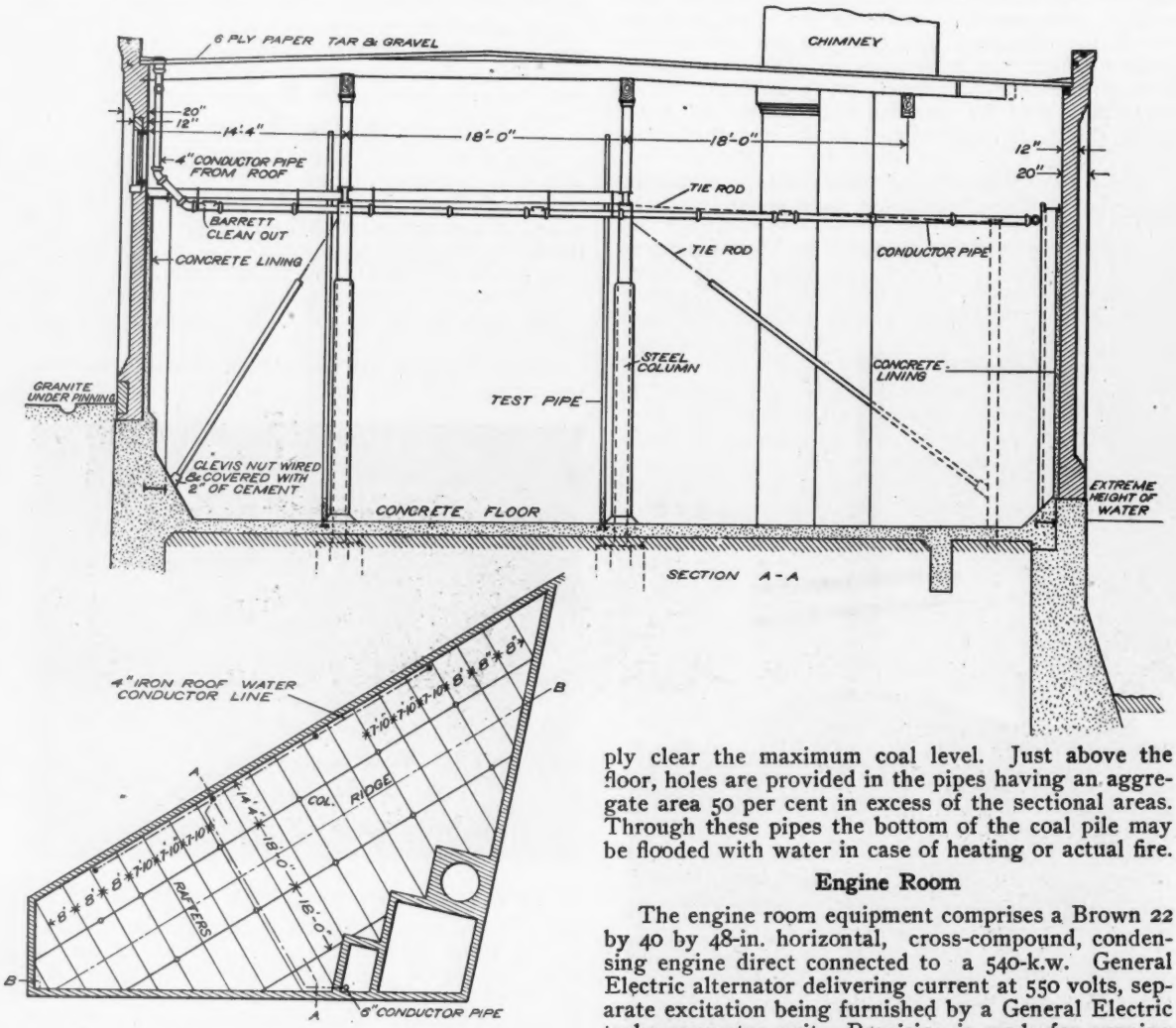


FIG. 2. SECTION AND PLAN OF COAL POCKET

The roof is supported by the brick walls and columns, the concrete lining carrying none of the weight. Short 6 by 6-in. Georgia pine posts directly over the columns support longitudinal 10 by 16 in. pine beams 18 ft. on centers. Eight by 12-in. rafters spaced about 7 ft. 10 in. apart rest on the beams and support the 2.5 in. grooved and splined spruce plank roof. The latter is covered with 6 ply tar and gravel roofing and pitched 0.5 in. to the foot. Inside drainage is employed.

Diagonal steel tie rod bracing with turn buckles is used in conjunction with the columns, and connection is made thereto by clevis nuts, wired and covered with 2 in. of concrete. Up to a height of 15 ft. these rods are encased in boiler tubes with cement between. The floor is of concrete, 9 in. thick, finished with troweled surface.

For the purpose of taking the temperature of the coal at various points, test pipes of extra heavy 2.5 in. diameter wrought-iron pipe are provided close by each column, their lower ends being imbedded in the concrete floor, while their tops are sufficiently high to amply clear the maximum coal level. Just above the floor, holes are provided in the pipes having an aggregate area 50 per cent in excess of the sectional areas. Through these pipes the bottom of the coal pile may be flooded with water in case of heating or actual fire.

Engine Room

The engine room equipment comprises a Brown 22 by 40 by 48-in. horizontal, cross-compound, condensing engine direct connected to a 540-k.w. General Electric alternator delivering current at 550 volts, separate excitation being furnished by a General Electric turbo-generator unit. Provision is made for running the engine noncondensing or operating either cylinder as a simple engine.

The auxiliary apparatus and most of the steam and water piping are located in the basement beneath the engine room.

Before entering the condenser the exhaust steam from the low-pressure cylinder passes through the 1200-h.p. primary heater for heating the boiler feed water, and the exhaust steam from the turbo-generator set and air pump is also utilized for heating feed water in a secondary heater. Vacuum is maintained by a Blake 12 by 26 by 18-in. twin vertical air pump and jet condenser. Ten-inch injection and 14-in. overflow pipes are provided in conjunction with the air pump and condenser.

The high-pressure steam piping is designed for 150 lb. boiler pressure, all above 4 in. diameter being of

steel with Van Stone flanges; smaller sizes are of wrought iron with screwed flanges. Cold feed water piping is of wrought iron, receiver pump discharge pipes including those carrying hot feed water being lead lined. All traps are bypassed so that any one may be removed without crippling the system.

The low-pressure piping is designed for 5 to 10 lb. pressure. Eight-inch pipes with valves at each end connect each boiler with the 14-in. steam header from which the various pumps and engines are supplied, and all other branch pipes are fitted with valves at both the header and receiving ends. The steam pipes are in all cases laid out so as to allow for expansion.

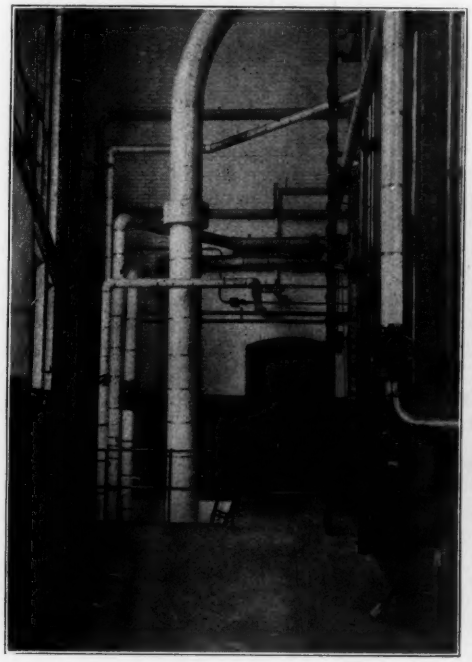


FIG. 3. PIPING IN BOILER ROOM

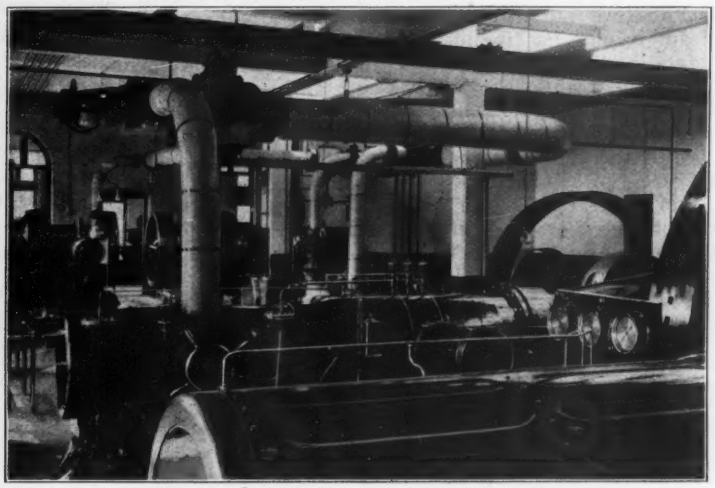


FIG. 4. VIEW IN ENGINE ROOM OF STARRETT POWER PLANT

This new steam power plant supplements the water power furnished by the Millers River, in which the flow of water, over a dam of 18 ft. fall, is very uniform throughout the year, and drives Sampson turbine wheels of some 500 h.p., built by James Leffel & Co., Springfield, Ohio.

RAISING WATER BY AIR LIFT

Recently I visited a plant which raises water by an air-lift equipment. The plant concerned was located in a building of the Young Men's Christian Association, the physical department of which is equipped with numerous shower baths and a swimming pool, having a capacity of 25,000 gal. The bathing facilities offered by the institution necessitate a water supply from a driven well, because of the cost of purchasing water from the municipality, the well being approximately 600 ft. deep, the water standing within 25 ft. of the top of the well. The air is compressed to a starting pressure of 110 lb. and an operating pressure of 75 lb. by an Ingersoll-Sargent compressor working at 80 lb. steam pressure. Water is discharged into a tank in the basement from which it flows by gravity into the pool, water for the shower baths being first pumped through heaters and thence to the shower room.

Operation of this device is dependent on 2 principles; the first is the difference in weight of 2 bodies of water, one of which is the water in the well, the other is the water which is contained in the discharge pipe. When the air, under pressure, is forced down the air pipe into the water-filled discharge pipe, part of the air permeates or saturates the water in the discharge pipe, thus making that body of water lighter than the water in the well. Thus the lighter body of water is forced up the discharge pipe by the pressure or weight of the other body acting at the lower end of the pipe.

At this instant the second principle is brought into action. The air which is forced into the discharge pipe is under pressure and naturally tends to expand proportionally as it rises in the pipe. This expansion of the air must necessarily be accompanied by the displacement of some other body, so as to make room for the expanding air. But the only remaining body is the water in the discharge pipe, so in this manner the water is displaced by the air, and is forced up and out of the pipe into the tank.

As the water stands within 25 ft. of the top of the well, other means of pumping it may be employed perhaps more economically, but the air-lift presents probably the most convenient method.

A POINT IN FAVOR OF ROPE power transmission that seldom receives the attention it deserves in considering the relative merits of belt and rope drives is the added advantage of safety. A rope invariably shows its weakness in time to allow of its being repaired. Such a defect is easily detected, even while the engine is running, allowing ample time in which to stop and remove the cause before the rope separates. In the multiple system, should one rope break and come off entirely, the others of the group would carry the load and prevent the engine from racing.

BY THE WHEATSTONE SYSTEM of relay working a telegram can now be sent from London to Rangoon in Burma direct without repeating; a distance of 7,970 miles.

"ALL OF US have some work to do which we do not enjoy. To do that work with enthusiasm is not so easy. But the secret of success lies in our doing with our might whatsoever our hands find to do."

THE LOW-PRESSURE STEAM TURBINE—II

WILL IT PAY? COMPARISON WITH LOW-PRESSURE RECIPROCATING ENGINE CYLINDER

By L. L. Willard

WHETHER or not the installation of a low-pressure turbine is warranted in any plant can be answered only after a careful analysis of the character and conditions of operation of that particular plant. As will be shown later, there can be not question about the increased efficiency attainable, and the consequent increase of capacity or decrease of power cost.

In plants, such as rolling mills, where the engines are intermittent in their operation, conditions are such that there is but little doubt that the low-pressure steam turbine has found a valuable field; in power plants, however, where the engines may be operated condensing, while the low-pressure turbine will undoubtedly show added efficiency, the probable remaining useful life of the engine to which it is to be tied, as also the future increased demand for power, and the value of a spare unit must all be weighed.

In general it is safe to say that in large plants, comprising 2 or more modern engines, the low-pressure turbine has a proper place: Whereas in small

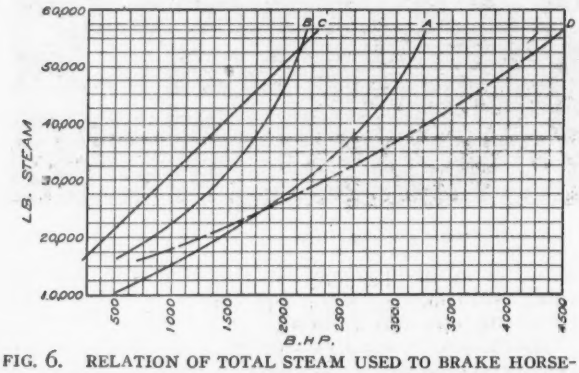


FIG. 6. RELATION OF TOTAL STEAM USED TO BRAKE HORSEPOWER. A, COMPOUND ENGINE, CYLINDER RATIO 6.5 TO 1 CONDENSING; B, WITH 4 TO 1 RATIO NONCONDENSING; C, ENGINE STEAM AND LOW-PRESSURE TURBINE CAPACITY; D, STEAM USED AND COMBINED OUTPUT OF ENGINE AND TURBINE, = B + C

plants having only 1 engine, and this perhaps in the last stages of decrepitude, it would generally be better policy to install a complete high-pressure condensing turbine of the full power required and to hold the engine solely as a spare.

Vacuum Needed

As the effective range of pressure in a low-pressure turbine is naturally small, a good vacuum is of far greater importance than with any other type of steam power generator as has been shown. Unless a vacuum at least equivalent to 26-in. referred to a 30-in. barometer can be economically maintained the installation of this machine can scarcely be justified. Nor is it fair to compare what can be done by installing a low-pressure turbine to operate with very good vacuum, with what is being done by an engine with a very poor vacuum.

To obtain the same degree of vacuum when condensing a given weight of steam under the similar conditions will cost just the same whether such steam can be exhausted directly from a reciprocating engine or a high-pressure turbine; or passed through a low-pressure turbine; and, for this reason, the following comparisons are all based upon a constant vacuum, namely 28-in. referred to a 30-in. barometer. For the sake of simplicity, also, one unit throughout is considered, and that of a medium capacity. The efficiency of a steam turbine increases with its capacity to a much greater extent than does that of an engine; the results would therefore be more favorable to the turbine in larger and less in smaller units or installations than shown by the diagram.

In considering the expansion diagrams Figs. 2 and 4, it must be remembered that they indicate the expansion of any unit volume and are a measure of power proportional to such unit; for instance, the unit volume may be 25 per cent of the cylinder volume, or 75 per cent of same.

Figure 2, as was explained in the previous article, indicates the proportionately greater loss in the engine exhaust at heavy than at light loads; namely a loss of 93 volumetric expansions with an initial volume of 25 per cent of the high-pressure cylinder, and 110.3 expansions with 75 per cent initial volume, in a compound-condensing engine, having a cylinder ratio of 6.5 to 1, and operating with 190 lb. absolute initial pressure, and 28-in. vacuum.

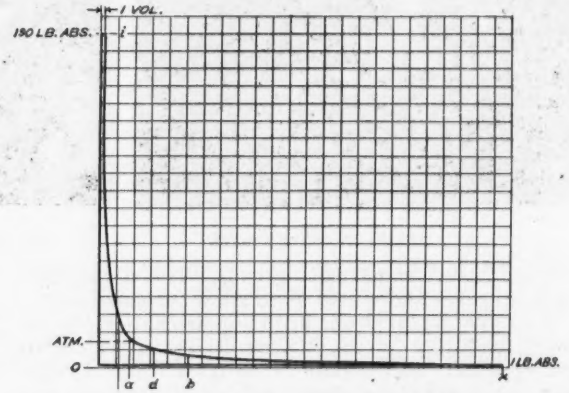


FIG. 7. COMPARATIVE EXPANSION OF STEAM IN THE 6.5 TO 1 AND 4 TO 1 COMPOUND ENGINES

First Comparison

Taking as a basis for our first comparison, a good compound Corliss engine of 2100 h.p. (say 1500 k.w.) rated capacity, with a cylinder ratio of 6.5 to 1, operating under the conditions shown in Fig. 2. At its rated load, with about 30 lb. indicated m. e. p. (referred to the low-pressure cylinder) its steam consumption will be about 13.7 lb. per horsepower-hour, or a total of 28,700 lb. per hour; and at 50 per cent overload about 16.1 lb. or a total of 50,000 lb. per hour. With long range cutoff gear this engine will carry a peak of 3250 hp. with a total consumption of 56,500 lb. per hour.

Curve A, Fig. 6, shows the relation of the total steam consumption and brake horsepower load of this

engine operating condensing under the stated conditions. It would not be feasible to operate this engine non-condensing with its high cylinder ratio of 6.5 to 1; as even with a cutoff as late as 75 per cent of the high pressure cylinder volume, the terminal pressure in the low-pressure cylinder would closely approach atmosphere, while with shorter cutoffs it would fall considerably below atmosphere.

Of course the turbine could be proportioned to use this steam at an inlet pressure below atmosphere, but this would put the low-pressure cylinder, and all the

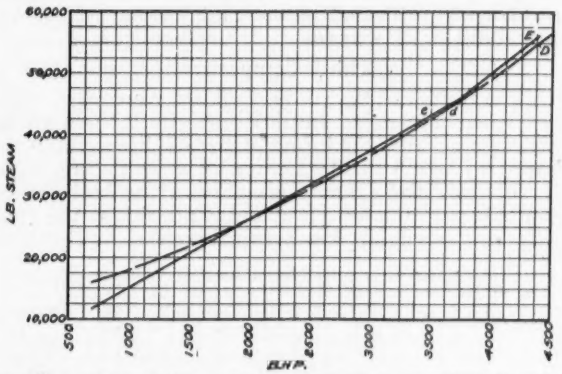


FIG 8. STEAM USED AND HORSEPOWER IN COMBINATION INSTALLATION, CURVE D, AND IN STRAIGHT TURBINE INSTALLATION, CURVE E

connections from the engine to the turbine, under vacuum, resulting in air leaks into the system which would render more difficult the maintenance of a good vacuum at turbine exhaust.

On the other hand, if an inlet pressure at atmosphere, or over, were maintained at the turbine, the engine with 6.5 to 1 cylinder ratio would generally be running with a very considerable loop in the low-pres-

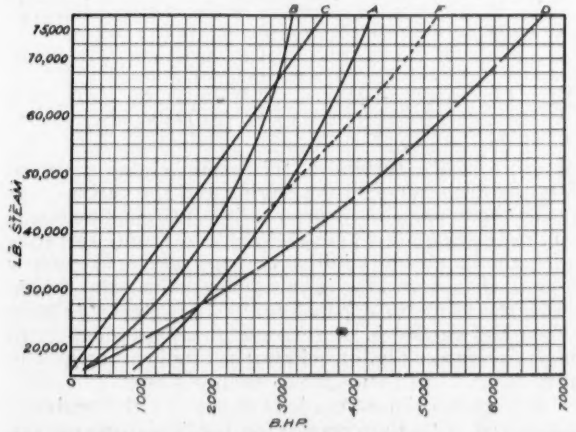


FIG. 9. STEAM USED AND HORSEPOWER; A, FOR A COMPOUND CONDENSING ENGINE, 4 TO 1 CYLINDER RATIO; B, SAME ENGINE, NONCONDENSING; C, EXHAUST TURBINE; D, COMBINATION UNIT

sure card. It might seem as if this could be done by increasing the diameter of the high-pressure cylinder, but, in practically all cases the frame and pins of the engine would not safely carry the increased stresses. The only alternative is, therefore, to reduce the cylinder ratio by reducing the diameter of the low-pressure cylinder.

This change reduces the maximum capacity of the engine to about 2200 h.p., when operating with 190 lb. absolute initial pressure and a constant back pressure of 18 lb. absolute. The steam consumption under these conditions is indicated by curve B on Fig. 6.

Between the engine exhaust nozzle and the turbine inlet there must be interposed an oil and water separator which causes a pressure drop of, say 2 lb.; moreover, there is considerable moisture in the engine exhaust. Deducting this moisture and allowing for the pressure drop, the low-pressure turbine will carry a maximum load of 2300 h.p. with the steam exhausted from the engine when it is developing 2200 h.p.

Curve C, Fig. 6, shows the relation between low-pressure turbine capacity and the steam consumption of the engine; i. e., the total steam as stated in this diagram is the steam delivered to the engine in relation to the load on the turbine, as well as that on the engine. Curve D, Fig. 6, is the sum of curves B and C and shows the combined output of the engine and low-pressure turbine. It will be noted that the maximum quantity of steam—56,500 lb. per hour—develops in the condensing engine, of 6.5 to 1 cylinder ratio 3250 h.p. In the noncondensing engine, changed to 4 to 1 cylinder ratio, this quantity of steam develops 2200 h.p. and in the low-pressure turbine 2300 h.p. after

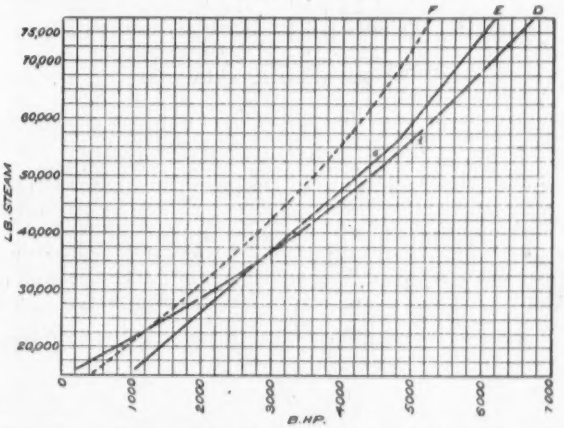


FIG. 10. COMPARISON OF STEAM USED AND CAPACITY FOR COMBINATION UNIT, CURVE D, AND TURBINE ALONE, CURVE E

passing through this engine, or a total of 4500 h.p., an increase in output of 1250 h.p. or 38.5 per cent.

This gain over the condensing engine gradually diminishes; until, at a total output of 1800 h.p. it becomes zero, and, below this load, a negative quantity. The maximum loads at which the units may be operated continuously without injury, assuming the output to be alternating current are indicated by the crosses in the curves, the spots being the rated capacities.

The expansion diagram, Fig. 7, shows the reduction in power and coincident increase in release pressure resulting from a decrease in the low-pressure cylinder area to 4 times the high-pressure cylinder area, from an original 6.5 times. Cutting off at 25 per cent of the high-pressure cylinder volume the range of expansion will be from i to b in the 6.5 to 1 engine, but only from i to d in the 4 to 1 engine. Cutting off at 75 per cent of the high-pressure cylinder volume, the range of expansion will be from i to a in the 6.5 to 1 engine, but only from i to c in the 4 to 1 engine.

Comparative Efficiencies

It is then a question whether it might not be better to install a high-pressure condensing turbine unit having about the same capacity as the combined engine

and low-pressure turbine. The comparative efficiencies are shown in Fig. 8, in which curve D is a reproduction of curve D of Fig. 6, and curve E the relation of steam consumption and load in an approximately equivalent high-pressure condensing turbine. The difference in efficiency is so slight that the decision as to the character of the new apparatus must be based upon the comparative cost of the turbines and their auxiliaries, and the conditions of operation and future power requirements.

The natural question is provoked by these comparisons; namely, in view of the admitted higher efficiency of the reciprocating engine in the higher ranges of pressure, why does not the combination of engine and low-pressure turbine display a marked higher efficiency than does a single high-pressure condensing turbine of equivalent total capacity? The answer is found in the very important loss occurring between the low-pressure exhaust and the turbine inlet, at which point a drop from a pressure of 18 lb. absolute to a pressure of 16 lb. absolute is equivalent to a loss of 2.5 per cent of the total available energy, or 3 to 3.5 per cent of the actual work.

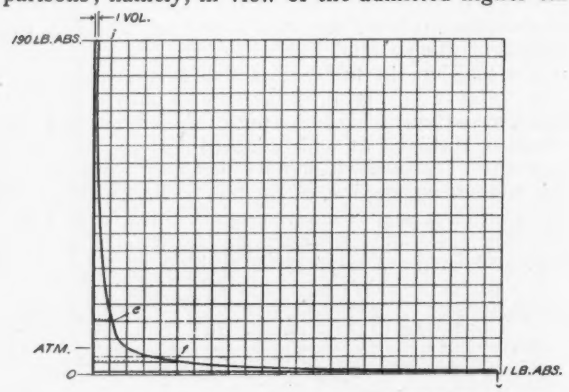


FIG. 11. EXPANSION OF STEAM IN ENGINE, EXHAUSTING DIRECT TO TURBINE

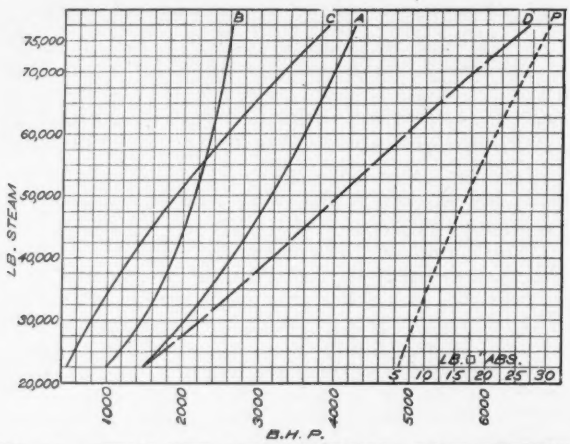


FIG. 12. STEAM USED AND HORSEPOWER, BACK PRESSURE VARIABLE; B, CURVE OF STEAM USED AND ENGINE HORSEPOWER, THE BACK PRESSURE FOR EACH STEAM CONSUMPTION BEING SHOWN BY CURVE P; C, CORRESPONDING TURBINE POWER; D, COMBINED POWER OF ENGINE AND TURBINE FOR DIFFERENT STEAM CONSUMPTIONS

Second Comparison

Figures 9 and 10 represent the same comparisons as Figs. 6 and 8, except that they take as a basis a compound Corliss engine having an original cylinder ratio of 4 to 1 and the same rated capacity of 2100 brake h.p. based on this ratio, so that no change need be made in the engine when its operation is changed from condensing to noncondensing.

In the foregoing comparisons it has been assumed that the engine when operated in conjunction with the low-pressure turbine will exhaust against a constant back pressure of about 18 lb. absolute, and that the division of load between the units will be such that the turbine will utilize all of the engine exhaust; but not any additional live steam.

Third Comparison

The results of the comparison are somewhat modified when the engine and low-pressure turbine are so tied together that the former exhausts directly into the latter, without the intervention of a regulating valve. In this case the exhaust pressure at the engine rises and falls with the total load and is practically the pressure at the engine low-pressure release. The inlet pressure at the turbine is this same release pressure, less the drop between the engine and the turbine.

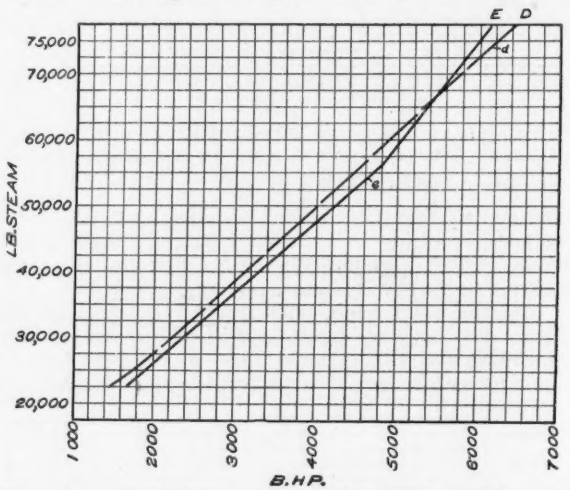


FIG. 13. COMPARISON OF COMBINATION UNIT AND STRAIGHT TURBINE UNIT; D, COMBINATION; E, TURBINE

In the expansion diagram, Fig. 11, for a compound engine, having a cylinder ratio of 4 to 1, and operating with 190 lb. absolute initial pressure, and a vacuum of 28-in. referred to a 30-in. barometer, the point f indicates the range of expansion and the release pressure when the engine is cutting off at 25 per cent of its high-pressure cylinder volume; and point e when cutting off at 75 per cent of the high-pressure.

The proportion of the load carried by the engine as compared with that carried by the low-pressure turbine, will therefore be greater at low loads and less at high loads. This is clearly set forth by curves in Fig. 12, in which curve B shows the relation of load and steam consumption of the engine operating with 190 lb. absolute initial pressure, and absolute back pressures, as shown by curve P (in which the back pressure is referred to the steam consumption:) and the relative load as shown by curve C. In this diagram, again, curve D is the combination of B and C; and Fig. 13 compares this combination with an equivalent high-pressure condensing turbine unit.

Finally, in Fig. 14, are shown curves deduced from the foregoing diagrams and showing the steam consumption per horsepower hour, with reference to the

load for a Corliss engine having a cylinder ratio of 4 to 1, and operating with 190 lb. absolute initial steam pressure, and 28-in. vacuum referred to a 30-in. barometer, as shown by curve A, Figs. 9 and 11, which is also the basis of curve a. Curve b refers to the combination of this engine, operating with a constant back pressure of 18 lb. absolute, and a low-pressure steam turbine, as shown by curve D, Fig. 9. Curve c refers to the combination of this engine, operating with varying back pressure, and a low-pressure turbine, as shown by curve D, Fig. 12. Curve d refers to a high-pressure condensing steam turbine of a capacity approximately equivalent to the combined engine and low-pressure turbine, and operating with dry saturated steam at 190 lb. absolute, and a vacuum of 28-in. referred to a 30-in. barometer.

The diagrams previously referred to do not indicate the efficiency obtainable by the addition to the steam engine plant of a high-pressure condensing turbine having a capacity equivalent to the low-pressure

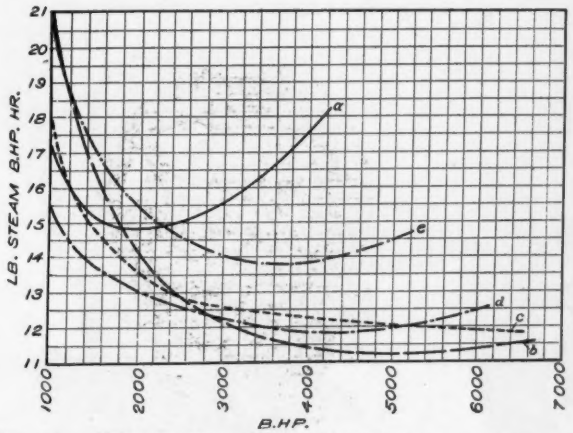


FIG. 14. COMPARISON OF STEAM CONSUMPTION FOR DIFFERENT CONDITIONS; CORLISS ENGINE, CYLINDER RATIO 4 TO 1, 190 LBS. ABSOLUTE PRESSURE, 28 IN. VACUUM; A, ENGINE ALONE; B, ENGINE AT 18 LB. ABS. BACK PRESSURE AND LOW-PRESSURE TURBINE; C, ENGINE WITH BACK PRESSURE VARIABLE, AND LOW-PRESSURE TURBINE; D, HIGH-PRESSURE, CONDENSING TURBINE INSTALLATION

turbine which might be installed in connection with the engines. For instance, diagrams showing the performance of an engine and a low-pressure turbine having a combined maximum capacity of 4500 h.p. are compared with a high-pressure condensing turbine of the same maximum capacity of 4500 h.p. but are not compared with the performance of the engine operating condensing, in conjunction with a high-pressure condensing turbine of a maximum capacity approximately equal to that of the engine; that is, its capacity is approximately ½ the combined capacity of the engine and low-pressure turbine.

Such combination of condensing engine and high-pressure condensing turbine would naturally be considerably lower in efficiency than either the combination of engine with low-pressure turbine or of the larger installation of the large high-pressure condensing turbine. And, unless plant conditions warrant the installation of the large high-pressure turbine, or are such that considerations other than efficiency make it preferable to install a small high-pressure condensing turbine as a separate unit from the engine, there is no question but that in first cost as well as efficiency, the low-pressure steam turbine to run in combination with the engine would offer by far the most attractive proposition.

It will be seen from the foregoing that while a low-pressure steam turbine installation in itself is comparatively simple, yet the conditions should be well investigated, taking into consideration not only the economy of the turbines and engines, but also the initial cost, depreciation, maintenance and the usual features which should be used to determine the actual cost of power delivered to the switchboard.

Before going ahead too far with any proposed installation of low-pressure steam turbines, I would sug-

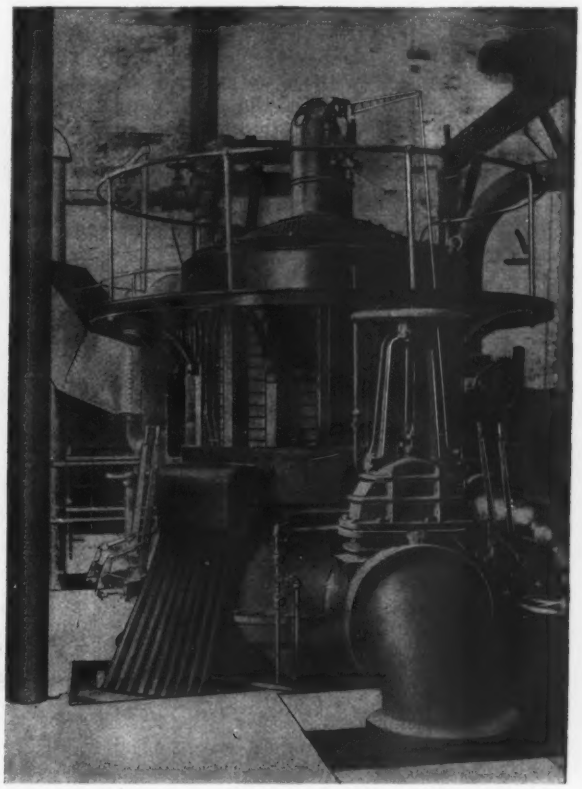


FIG. 15. 800 KW. LOW-PRESSURE CURTIS TURBINE UNIT

gest that a reliable manufacturer with extended experience in this line be freely consulted. It has been previously stated that a drop of 2 lb. in pressure between the exhaust from the engines and the turbine inlet, is equivalent to 3 to 3.5 per cent actual work. It will be seen by this how important it is to connect the engines to the turbine properly, using an oil and water separator properly designed to reduce the drop to a minimum, and so located as to keep condensation down to the minimum.

"SOME HAPPY TALENT and some fortunate opportunity may form the 2 sides of the ladder on which some men mount, but the rounds of that ladder must be made of the stuff to stand wear and tear; and there is no substitute for thoroughgoing, ardent and sincere earnestness."

MOTOR TROUBLES seem to be just as perplexing and just as simple on flying machines as elsewhere. On a recent flight the motor stopped on the military machine which Messrs. Wright and Lahm were flying, and after a fruitless hunt of several hours through valves, igniter and pipes,—the gasoline tank was found to be empty.

THE AUGUSTINE ROTARY ENGINE

WITH AUTOMATIC CUTOFF GOVERNOR AND BALANCED PISTONS

FOR developing a large amount of power in a small space, the Augustine Rotary Engine has proved itself well adapted and in many plants has shown itself to be a practical working machine requiring little attention and giving good satisfaction.

It has a number of novel features worked out through years of experiment by the inventor, Benj. F. Augustine, who is President of the Augustine Automatic Rotary Engine Co., of Buffalo, N. Y.

Regulation.

Illustrations herewith show the action of the engine and the design on which its success depends. In Fig. 1 is seen the assembled engine ready to run. It has a flywheel governor of special design which controls the speed accurately between no load and full load by changing the position of the eccentric.

This eccentric drives by means of an eccentric rod and rocker arm the oscillating valve, the driving mechanism being shown on the base of the engine in Fig. 1 and also at the bottom of the engine casing, Fig. 2. In Fig. 2, the ports through which the valve admits steam are in the bottom of the casing, one of them being seen where the revolving piston on the near side has been removed.

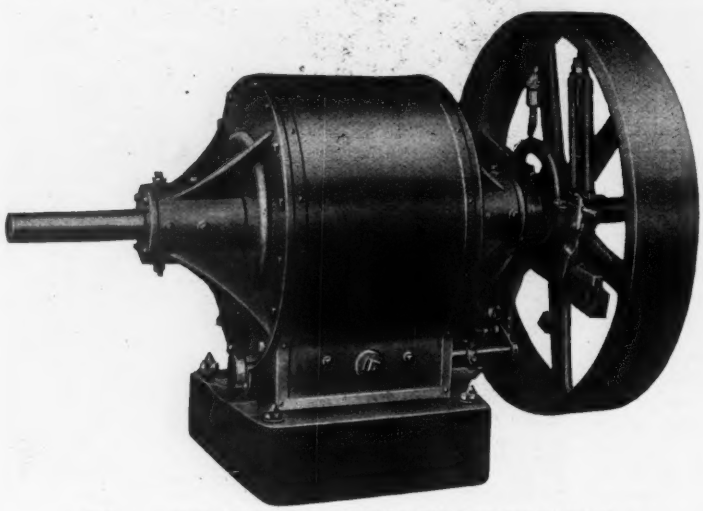


FIG. 1. THE AUGUSTINE AUTOMATIC ROTARY ENGINE

FIG. 2. INTERIOR VIEW OF AUGUSTINE ENGINE WITH NEARER PISTON REMOVED AND VALVE PULLED OUT TO SHOW PORTS

The ports in the casing are in line but the ports in the valve are staggered so that as the valve rocks back and forth steam is admitted first to one piston, then to the other. The pistons are mounted central to the outside casing, as shown in Fig. 2 and are held in this position by bearings in the heads, Fig. 3, these bearings being adjustable by means of set screws so as to keep the piston always bearing on the bottom of the eccentric abutment piece which forms the steam cylinder, this bearing being indicated in Fig. 2.

The abutment is shown by itself in Fig. 4, which also shows the ports for exhaust at the left and just the ends of the steam inlet ports at the right near the bottom.

Pistons

The pistons revolve. They are 2 in number with flanges at the ends and between the 2 pistons, giving steam-tight joints. These flanges fit down on either side of the abutments and are the full size of the bore of the outer casing.

In each piston is a counter-balanced blade seen in Fig. 1, the blade being at the lower right hand side of the piston and the counterbalance in a slotted arm of the piston at the upper left hand. This blade laps across the flanges of the piston so that the pressure of the steam seals them and makes a tight joint. These blades have, as shown in Fig. 3, a long arm on one side and a short arm on the other and on the ends of these arms, as shown in Fig. 2, are crossheads which run in grooves in the covers as indicated in Fig. 3, to keep the blades traveling central with the bore of the cylinder.

Steam Action

As the piston blade crosses over the lower center of the engine, the valve rocks to open the port and admit steam behind the blade; this forces the revolving piston around and the valve rocks to cut off steam at the point required by the load, as indicated by the governor action.

From this point of cutoff, expansion takes place ar when the blade on one side reaches its uppermost position, the blade on the other side crosses the lower center and that piston begins to take steam. Thus one cylinder always has steam expanding while the other is taking steam at initial pressure. Steam exhausts without the action of a valve when the blade crosses the opening to the exhaust port shown in the abutment, Fig. 4.

Care has been taken to provide steam-tight joints at all points. On the inside edge of the abutment is a packing ring to bear against the flange on the piston. At the bottom of the abutment is a packing block to prevent any possible circulation of steam from the live steam to the exhaust steam side of the piston. The outer edges of the blades make, of course, a steam-tight joint with the abutment at all times. These joints are arranged to take up their own frictional wear and the careful design of the engine and the balancing

of all parts is such as to reduce wear to a minimum.

The ends of the blades are housed in by the flanges of the pistons so that leakage cannot occur past these ends, and carrying the ends of the blades through to the crossheads which run in the heads or covers, insures accurate travel of these blades and freedom from vibration. The exhaust of the engine is so arranged that admission of steam and expansion take up about 320 deg. of the circle of revolution, and exhaust the remaining 40 degrees. The arrangement of the governor and valve is such that the engine can be reversed at any time and when running at any speed.

An idea of the compactness of the engine is had from the dimensions of 3 sizes. The 20-hp. has a height of 18 in. and a base 14 by 15 in., while the 45-hp. has a height of 27 in. and a base 20 by 24 in. A 100-hp. engine recently installed in the planing mill of the Dodge-Bliss Co., at Tonawanda, N. Y., is 36 in. high, has a base 32 by 40 in., and a 4 -ft. flywheel.

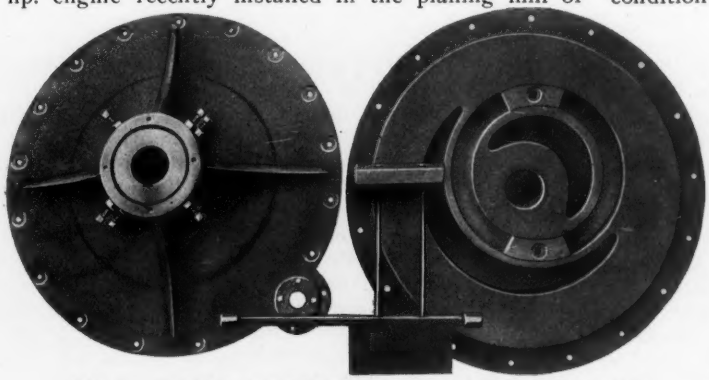


FIG. 3. OUTSIDE AND INSIDE OF COVER AND PISTON BLADE WITH ARMS AND COUNTERBALANCE

FIG. 4. ABUTMENT SHOWING PORTS AND RINGS TO MAKE STEAM JOINTS

Shop tests of the engine made on Mar. 20, 1909, at 95 to 102 lb. pressure, with the generator giving 110 volts and 104 to 112 amperes gave a water consumption of 622 lb. per hour at 21 hp. and 631 lb. at 22 hp., or an average of 29 lb. an hour a horsepower. Five amperes was reckoned as the equivalent of an engine horsepower and all water was condensed and weighed.

THE IDEAL BOILER FURNACE

The ideal boiler furnace is the one that insures complete combustion of the fuel, including both gaseous and solid constituents before the fuel begins to give up its heat to the boiler. This ideal cannot be attained with any arrangement which allows the furnace or fire to become chilled, for the chemical action of combustion takes place only when a high temperature is maintained for an appreciable length of time.

The chief causes of the chilling are the frequent opening of fire doors when hand firing is practiced, and the close proximity of the cool heating surfaces of the boiler which have a refrigerating effect on combustion. It is a well known fact that if combustion is not completed before the chilling begins it never will be completed, for the gas will not again be brought to a sufficiently high temperature.

The second important factor upon which the ideal furnace depends is the air supply. Too much air causes losses due to the heating to a high temperature the inert nitrogen and the heat contained in the nitrogen escapes from the stack. Too little air means that the supply of oxygen is not sufficient to cause complete combustion; to be completely burned the carbon must be changed to carbon dioxide gas, and chemically speaking this gas cannot be formed unless 2 atoms of oxygen are present to unite with 1 atom of carbon.

Smoke at the top of the chimney is due to suspended carbon in the gases; it is an indication of incomplete combustion caused by too little air. If just the right amount of air is being admitted to the furnace, or if too much air is supplied there will be no smoke, for complete combustion will take place because of the ample supply of oxygen.

It is shown by chemistry that when coal is burned to carbon monoxide (incompletely) instead of carbon dioxide (completely) the carbon produces less than one-third of the heat that is produced when completely burned.

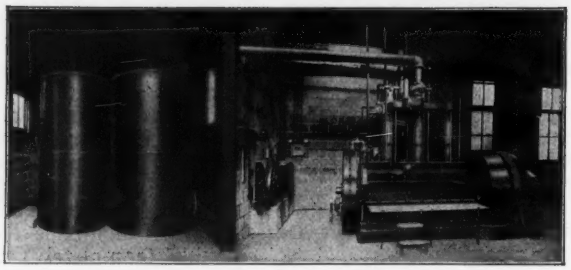
Since the appearance of the top of the stack or the fire itself does not enable one to determine the exact condition of combustion, the apparatus for finding the constituents of the flue gas is used because the percentages of carbon dioxide, carbon monoxide and oxygen show definitely the state of combustion.

Chemical calculations show that for the best results with average coal the percentage of carbon dioxide should be 15 or 16. If much lower the combustion is incomplete and the analysis will show an appreciable amount of carbon monoxide. More than 16 per cent is almost impossible unless there is too little air, and if so some carbon monoxide will be formed. As to the free oxygen, the best results will be obtained with from 5 to 8 per cent. Less than 5 per cent shows that there is barely sufficient oxygen for chemical combination with the carbon, and again carbon monxoide is likely to form. More than 8 per cent means too much air, evidenced by there being more oxygen than can unite with the carbon.

The above facts emphasize the importance of watching carefully for carbon dioxide, carbon monoxide, and oxygen, so that the firing, furnace, and fuel may be selected to give to the heating surfaces the completely burned gas. A series of tests recently made on a 650-hp. Babcock & Wilcox boiler equipped with a Taylor stoker, present a fine example of gas analysis, and illustrate what the underfeeding of coal combined with proper air regulation will do.

In 8 tests, the average percentage of carbon dioxide was 13.8, the maximum being 16.5. From this it would be expected that the percentage of carbon monoxide would be low, and in fact averaged less than 0.1 of 1 per cent. In a majority of the tests there was hardly a trace. The percentage of oxygen also is in accordance with our ideal, the average being 5. In 2 of the tests the carbon dioxide was high, 16.2 and 16.5 per cent, which caused an appreciable amount of carbon monoxide.

Gas Producers



And Engines

A QUEER GAS ENGINE PLANT EXPERIENCE

NOT THE FAULT OF THE ENGINE

By C. E. Bryson

I HAVE in mind a certain engine foundation which is the source of much perplexity to the owners, alarm to the natives and amusement to the traveling public. This foundation supports a large single-acting gas engine and when first installed and running rocked quite perceptibly in synchronism with the thrust of the pistons, and of late has grown to be such a serious matter that another of different design may have to be built.

Several wise men have volunteered their theories as to a cure, but up to date none have sounded good to the management. One advised changing the direction of the exhaust. As installed, the engine exhausted from its 2 cylinders, which are arranged in twin, into 1 pipe and out to one side, or at right angles to the bore of the cylinders. A change was made in the piping which permitted the engine to exhaust in a line parallel with the cylinder bores; result, nil. Another suggested running the engine at a different speed, and still another bolting a weight in the flywheel to counteract the piston thrust. Foundation for another unit is being constructed close to the troublesome member in the hope that they may be bonded together and thus reduce the motion to a certain extent.

As matters now stand, the vibrations set up in the surrounding earth are quite startling. A small iron safe in the office of the principal hotel a block away rolls back and forth perceptibly and those who retire to rest are reminded of the palmy days of the Bender family by the movement of the bed.

The doors of freight cars standing on a siding 2 blocks away have been heard to flap with each impulse. Numerous other instances can be cited and these multiply during a wet spell of weather while in the winter when the ground is frozen the pulsations are miminized, although the rocking of the foundation is uniform irrespective of climatic changes.

All bearings run cool as yet and none of the several gas, air and water mains leading to the engine have opened up, although it is impossible to say just when they will show leakage.

Digging the dirt away at one side preparatory for the second foundation aggravated the rocking tendency, which assumed alarming proportions.

When the new foundation was in place and connected by corrugated surfaces to the older one, there was an absolute cessation of all vibration for a week, at the end of which time the larger one seemed to pull away from the newer and at the end of a month there was a decided movement, the side next to the addition moving very little, while the other side, which was, comparatively speaking, free to move, showed unmistakable signs of a longitudinal movement.

It would appear then, that a torsional strain was taking place within the foundation and grave fears were felt that the hitherto monolithic block would split from top to bottom longitudinally. The flywheel-pit served further to augment their fears, and it was was resolved to build a similar concrete block adjacent to the free side.

This foundation was located in an electric light and power station and when the change from steam driven to gas driven units was decided upon, the officers unfortunately agreed to build on the same ground and within the same walls. I say unfortunately, as the operation and construction work conflicted to an enormous degree coupled with the fact that the location was unsuitable on account of the lowness and unstable soil in which there was a large percentage of water. This latter could be found 7 or 8 ft. below the surface and it was necessary to run pumps continuously while putting in the concrete.

The foundation print furnished by the engine builders was one suited only for bedrock, and the general shape of it was at variance with the requirements of supporting and holding in place a horizontal twin single-acting gas engine. The sides and ends were vertical and not stepped off front and rear as is the usual practice for engines of any description or character. When the buyer looked over the prints, this peculiarity was noted, but at the time it was thought that the large weight (180 tons) for such a sized engine would offset the seeming defect.

When the engine was erected and started, it was noticed from the first that a movement was apparent, but not much importance was attached to it, as it was thought in time that it would wear a bed of its own and possibly settle a trifle. Time went on, a little trouble was had with the bearings and when the heavy load came on during the winter months, it was noted that during the peak, the rocking of the engine caused the belt to slip a trifle with each pulsation of the engine, or about 90 times a minute.

Meanwhile the troubles to which all gas engines are subject came on apace, causing partial and complete shutdowns and exciting sarcastic remarks from the citizens and in view of a constantly increasing load a second engine was purchased of the same make and general design, but of a smaller size, and the foundation question was thoroughly looked into. The engine builders would advise nothing but piling and furnished foundation prints suited to such work.

Owing to the fact that the nearest pile-driver was

100 miles away and fearing that the repeated hammer blows would disturb the level of the running engine, it was decided to omit the piling and extend the print submitted by the builders. A footing was made double the area of that proposed, the foundation for one building wall being included with re-enforcements and the engine and generator foundations brought up as one piece, narrowing toward the top to correspond with the engine bed and generator base, the two machines being later connected by belt with 23-ft. centers. When this set was started, the absence of all vibration even at rated capacity was a revelation, and the necessity of piling disproved.

The next proposition was: How to save the larger foundation with the least expense and obtain best results. It was noted when the dirt was dug away at the side preparatory for the foundation for the new engine, that mud and slime were pumped up from underneath and thrown out by the rocking to and fro, indicating the presence of water in quantities.

A dry well was conceived as the solution to the problem and was accordingly dug and lined with concrete to a depth of 25 ft. and leading to it tile laid under the foundation, while under the process of construction. Further, a tile was laid at a depth of 13 ft. or 3 ft. below all foundations, entirely around the building. Also all roof eaves and down spouts were discharged into the tile. A pump was installed to hold the level of the water in the well automatically the same, and lift it to a tank on the roof which supplied water for the cylinder jackets. As the laying of the tile progressed, a cessation of violent motion was noticed and hopes were entertained of obtaining complete relief upon the completion of the project.

THE LIETZENMEYER CRUDE-OIL ENGINE

By J. C. Van Langendonck

IN burning crude-oil in internal combustion engines the great difficulty experienced is due to the fact that on account of its viscosity it is difficult to spray, and unless finely divided, it is impossible to mix such heavy oils with the quantity of air required for complete combustion. If combustion is incomplete, solids are deposited upon the cylinder walls, pistons and valves to so great an extent as to make continuous running a practical impossibility, and the smell of the exhaust is so obnoxious as to be a nuisance to all neighboring establishments and dwellings.

Up to the present, in Europe, the best known crude oil engine is probably that introduced by Diesel, some 10 yr. ago. On account of the nature of its oil-spraying device, this engine is, however, built only as a vertical engine, and this is attended with advantages under certain conditions. Recent improvements have mostly been directed toward the removal of this and some other disadvantages.

Four-cycle working, and the slow introduction of the fuel into the combustion chamber during a considerable portion of the working stroke, respectively adopted and introduced by Diesel, have, however, been retained. The prolonged introduction of the fuel constitutes the distinguishing qualification of internal "combustion" engines as opposed to "explosion" engines, in which the whole charge of fuel is in the working cylinder at the time of ignition, and burned momentarily as far as the speed of the propagation of flame permits.

A recently introduced crude-oil engine, of the horizontal type, is that known as the Lietzenmeyer engine. In appearance, this engine, of which we illustrate a specimen, is very similar to a well-designed gas-engine, except that 2 or 3 details, which with a gas engine would be unnecessary, are to be seen, while some indispensable adjuncts of a gas-engine are noticeable only by their absence.

The engine frame, of very strong design, is of the fork type, with the main bearings cast in one body with the frame. The arms connecting the frame with the respective bearings are brought well up above the center line of the engine to reduce bending strains as far as practicable. The cylinder liner is pressed into the body of the frame, and abuts upon a collar at the back of the engine, but is seated on a round packing-ring at the front to allow of free expansion.

To the body of the frame the valve-head is bolted in such a way that it holds, for the sake of double security, the liner in place. The space between the liner and the frame forms an amply large water jacket. The cast iron piston is of the open-trunk type, very long, fitted with cast-iron rings, and lubricated from a special oil-pump.

It moves on the back stroke practically to the end of the cylinder proper, leaving only quite a small amount of clearance. The compression chamber,

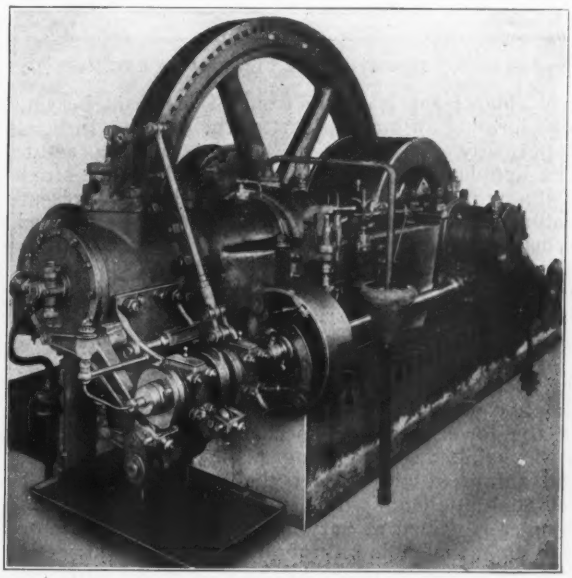


FIG. 1. THE LIETZENMEYER CRUDE-OIL ENGINE

therefore, is chiefly situated in the valve head. The engine has only 3 valves: the air-suction valve above, and the exhaust-valve below the cylinder, and on the end of the cylinder attached to a cover which closes the otherwise open water-space in the valve-head, the fuel injection valve.

The exhaust-valve seat is formed in the valve-head body, while the air-suction valve is seated on a sleeve inserted with the valve from above. This seat is cast in one with the bush in which the valve stem is guided. The fuel-injection valve is situated at a place to which the fuel has no access.

It is of the mitre-seated type, and, admitting only the spraying air, is not liable to get dirty or to become corroded.

The crank-shaft is carried in 3 2-part bearings, 1 close up on each side of the crank, the third, an outside bearing, beyond the flywheel, which is 9 ft. 2.5 in. in diameter, weighs 4.5 tons, and reduces the coefficient of fluctuation to about 1/50. From the other end of the shaft the side-shaft is driven through 2 to 1 screw gearing.

Beyond the gear-wheel, the main shaft carries a small crank and pin for driving the air-compressor. This auxiliary delivers compressed air for 2 purposes: first, for spraying the fuel; and, second, for setting the engine in motion. It is a 2-stage machine, with a trunk piston working in tandem with a prolongation of small diameter, which forms the high-pressure piston.

Its cylinder is inclined at an angle of 30 deg. with the center line of the engine, and is bolted to the ver-

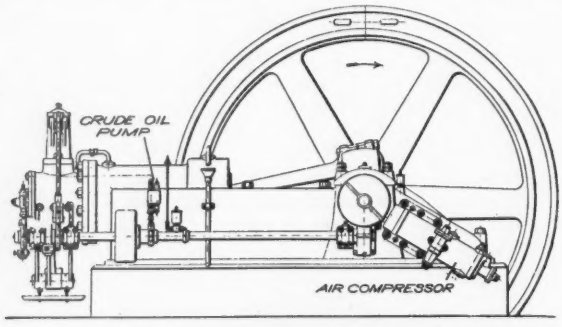


FIG. 2. LONGITUDINAL DIAGRAM OF ENGINE

tical side of the frame in front of the main bearing, thus forming an integral part of the engine. In it, air is normally compressed to 60 atmospheres pressure. The annular space formed at the end of the trunk-piston by the projection which forms the high-pressure piston is the low-pressure cylinder, and is unjacketed; it delivers air at 5 atmospheres pressure to an air-cooled intermediate cooler. The high-pressure cylinder draws air from the cooler, and forces it into the flasks provided for storing it. All valves are of the simple spring-loaded poppet type.

From the side-shaft all the valves are worked, and the fuel pump driven. The vertical fuel-pump is of simple construction, with its barrel open at both ends. In the lower end the mechanically-driven plunger works, while a second plunger is inserted at the upper end, and fitted with a lever, that may, if necessary, be actuated by hand when starting up. The working plunger is driven at varying stroke, according to the load upon the engine, through a double eccentric; the primary eccentric, which in this case is the outer one, being joined by a link to the governor-casing, whilst the secondary one can be turned upon the shaft by a Doerfel shaft governor.

While at work, the speed of the engine can be adjusted within wide limits by means of a handwheel, which shifts a collar lengthwise upon the shaft, and alters the tension of the governor springs.

The valves are actuated by means of cams in the way usual with small gas engines. The simple gear is well proportioned, and constructed with due attention to ease of erection and to accessibility in use. All the valves are closed by springs, and opened by the valve levers pressing upon the ends of their stems with rollers provided for the purpose. No mechanical connection exists between the valve levers and stems.

Special attention has been paid to the lubrication of the working parts. The main bearings and those carrying the side-shaft, are of the ring-oiling type. The main crankpin and air compressor crankpin are oiled centrifugally with oil from sight-feed lubricators. The piston pin receives its oil from a similar lubricator by means of a wiper. The eccentrics which drive the fuel-pump are also oiled centrifugally from a sight-feed lubricator delivering into a hole drilled longitudinally through the center of the side-shaft.

Three air-flasks and 2 oil tanks constitute the engine's accessories. One of the former is required to store air for starting the engine; one to supply the air used for spraying the fuel into the combustion-chamber; the third is only an emergency flask for use if, through any cause, the pressure in the starting-flask should fall below that required for the purpose. The starting up flask has a capacity of 7 cu. ft., the reserve flask is of the same size, while the one used in connection with the fuel-spraying apparatus has a capacity of but 1.4 cu. ft. The bodies of these flasks are drawn and rolled, each out of a solid steel ingot. The ends are electrically welded into place. The upper ends are fitted with screw-down valves, by which the flasks can either be connected among themselves to the engine, to to the air-compressor at will.

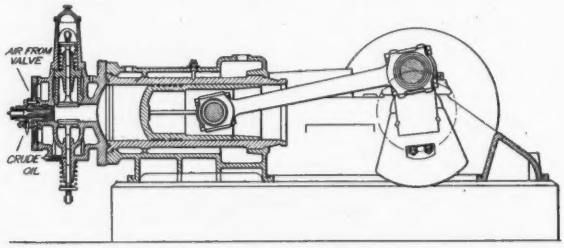


FIG. 3. SECTIONAL VIEW OF CRUDE-OIL ENGINE

Bodies of the valves are machined out of well-forged blocks of Siemens Martin steel, which material has proved less pervious than bronze or other cast metal. The normal pressure at which the air is stored is 850 lb. per square inch, but it occasionally rises to 1,140 lb. per square inch, so that the flasks are tested to 1,707 lb. The chief dimensions of the engine are as follows: Working cylinder, 13.75 in. in diameter, with 19.75 in. stroke, r. p. m. 185; air-compressor, 6.3 and 2.375 in. cylinder diameters, with 6.75 in. stroke; main bearings, 6.75 in. in diameter by 12.625 in. in length; connecting rod, about 53 in. long, with the crankpin bearing 7.5 in. and the small end bearing 4.9 in. by 6.75 in. in length.

Starting up and working the engine, when once the flasks are charged with air at sufficient pressure, is as follows: The engine is barred round until the crank is just past the dead center at the beginning of the combustion stroke; a roller on the lever which actuates the fuel-spraying valve is shifted so that it comes into contact with an auxiliary cam which gives a late cut-off; then the air valve on the starting flask is opened; air enters the cylinder through the fuel-spraying valve and drives the piston forward until exhaust takes place in the usual manner.

After about 2 such working strokes, 1 stroke of the hand fuel pump is sufficient to start combustion. The roller on the fuel-spraying valve lever is then returned to its normal working position, and the engine can be loaded up at will. If the engine must be started under load, the compression must be released while bring-

ing it up to speed. This is done by shifting the cam-roller of the exhaust-valve lever to engage with a second auxiliary cam which works the exhaust valve, as in a 2-cycle engine.

Working normally, the cycle of events is as follows: (1) First forward stroke; air suction; (2) first backward stroke; air compression 427 lb. to 497 lb. per square inch; (3) Second forward stroke; combustion and expansion; (4) second backward stroke; exhaust. During the fourth and first stroke the fuel is introduced into the fuel chamber, which is in open connection with the combustion chamber, and therefore at about atmospheric pressure. During the second stroke the oil is warmed through the heat of compression, but is unable to burn owing to its heavy character and to its being in a compact state in a confined space. At the beginning of the third stroke the fuel is sprayed into the combustion-chamber, where it ignites and burns readily. Expansion follows until release takes place, whereupon the gases are ejected during the fourth stroke.

The cooling arrangements are as follows: The water is first led to the high-pressure cylinder of the air-compressor, thence to the valve-head of the oil engine, and then to the jacket round the cylinder, first traveling round that part of the cylinder in which combustion takes place, and then to the cooler regions. Upon leaving the engine the heated water can be led to 2 oil-tanks or run to waste.

The crude oil can be of almost any quality so long as solid matter is not fed to the engine. If it contains much paraffin it must be heated sufficiently to keep the paraffin in a fluid condition. It may contain 2 to 4 per cent of benzine, but must not contain more, or preignition takes place. For this reason it is often advisable to use crude oil which has already been freed of its paraffin and benzine, especially as such oil, being mechanically clean, is not apt to damage the piston and cylinder liner.

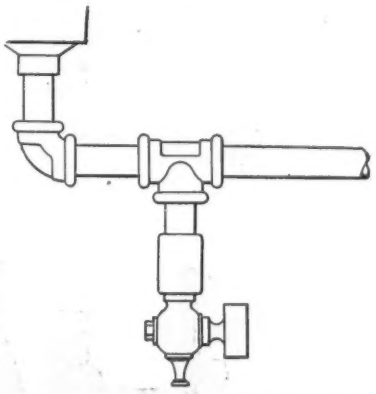
An engine of 50 hp. requires 10,000 calories per kilogramme—18,000 British thermal units per pound—and about 20 litres of cooling water per brake horsepower hour. The air-compressor consumes some 3 to 5 per cent, of the indicated horsepower of the engine, of which the total efficiency, i. e., the ratio of the brake horsepower available to the indicated horsepower developed in the working cylinder—75 per cent at normal full load and about 70 per cent at three-quarter load.

Amongst others, the following advantages are claimed for engines of this type: The fuel is fed into the engine at a time when the pressure in the fuel-chamber is a minimum (at about atmospheric pressure) permitting the fuel pump to be driven at variable stroke in the way described, and resulting in very exact governing. The spraying air has only to spray oil actually in the fuel chamber within the cylinder, and not to force fuel into the engine against great pressure. The spraying-air admission-valve controls only the compressed air inlet, and cannot, therefore, be fouled by the crude oil. No gage or opening with fine holes, but only a single smooth-bore channel, is required to accomplish spraying, and is not subject to injury or stoppage by impurities in the oil fuel or by the use of viscous oils.

Further, the fuel is not volatised, but only preheated in the fuel chamber, and does not, therefore, leave any deposit there. Combustion is stated to be perfect, so that the cylinder remains remarkably clean; the chief cause of need of periodic inspection and cleaning is that the lubricating oil leaves a deposit between the piston-rings. Such inspection, however, is only needed once in 6 to 8 weeks.

WATER IN GASOLINE

TROUBLE is oftentimes experienced with water in the gasoline for stationary engines which use that kind of fuel. A method given in the Gas Review by W. D. Graves is convenient for avoiding this difficulty. Generally the gasoline supply pipe is taken from the lowest point in the gasoline tank in order that the tank may drain completely. In order to avoid water, the end of the pipe is sometimes carried up into the tank a ways or is brought down from



PIPING ARRANGEMENT TO DRAIN WATER FROM GASOLINE

the top of the tank to near the bottom so that any water which collects in the bottom will not be drawn up until the water gets deep enough to cover the end of the supply pipe. Then all the gasoline cannot be drawn off.

The method suggested by Mr. Graves is to take the supply pipe from the bottom of the tank and where it turns to the horizontal put in a drip cock through which all water may be drawn out of the piping and the bottom of the tank, insuring gasoline which is free from water.

FOR MORE THAN 5 YR. a power station for the generation of electric current has been in operation at Skabersjo, Sweden, with peat as a fuel. The bog which supplies this covers about 37 acres, and has a depth of some 5 ft. which will supply fuel for a period of 30 yr. The peat is utilized in gas producers and by means of gas engines directly coupled to electric generators. The power is utilized 3 miles away for lighting streets and driving small factories.

A MOST REMARKABLE and record breaking flight was made by Orville Wright at Potsdam, Germany. Late in the afternoon, after a short flight with Crown Prince Fredrick Wilhelm, Mr. Wright mounted in circles steadily, for 15 min., until he reached a height which he estimates was 1637 ft., although onlookers judged it to be much higher. He then made a swift descent, coming down in about 5 min. and alighting safely.

THE WISE ENGINEER will run over in his mind from time to time the means and methods he will use to handle an accident when it happens, and how he can render its consequences as unimportant as possible, so as to know just what to do no matter in what part of the plant he may be when trouble arises.

NEW YORK SUCTION GAS ENGINE AND PRODUCER

ON the opposite page our readers will find a complete set of indicator cards taken at Watertown, N. Y. from a 9 by 16-in. single cylinder, 4-cycle suction producer gas engine, the generator gasifying ordinary commercial pea coal.

It will be noted that there are 18 separate indicator cards taken half-hourly from 8:30 in the morning till 4:45 in the afternoon. Each indicator card has marked on it the number of revolutions at which the engine was running at that time, the number of power strokes per minute and the mean effective or average pressure shown by said card. It is noteworthy that this small engine obtains a better mean effective pressure toward the end of the day when the generator has accumulated some clinker, than it obtained in the morning.

The inside diameter of the fire-brick lining of the gas generator measures 14-in. or very closely 1.06 sq. ft. the coal consumption per hour being about 15 lb. per square foot. The average mean effective pressure is shown by all the cards as 90 lb. per square inch,—certainly a remarkably fine result for a small gas engine running on anthracite pea coal. Such coal makes usually from 15 to 18 per cent ash and its B.t.us. will run from 12,000 to 12,500 per lb.

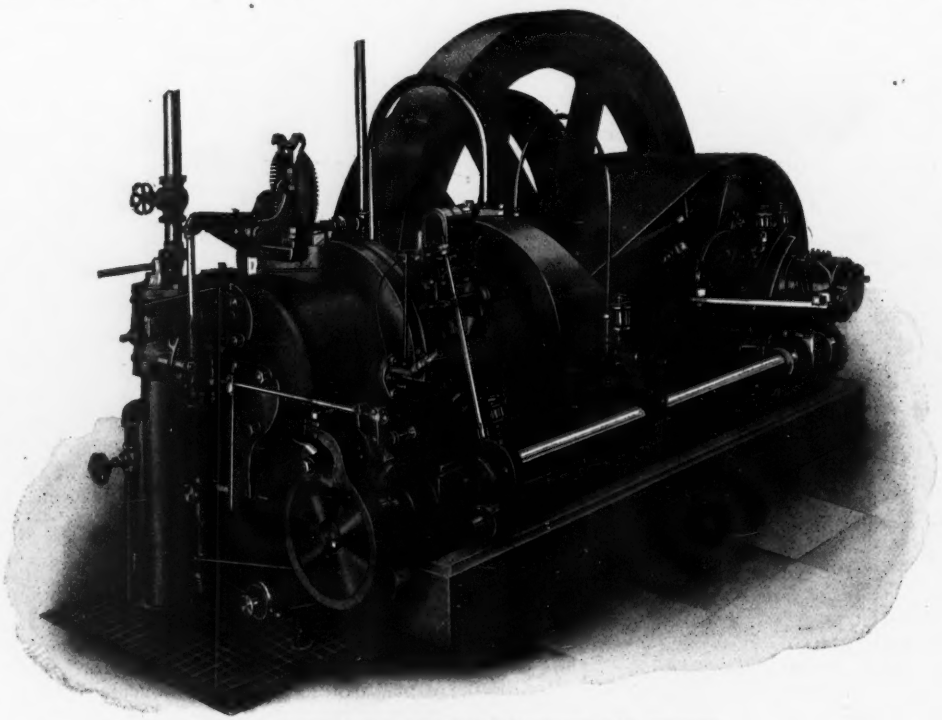


FIG. I. NEW YORK SUCTION PRODUCER GAS ENGINE

We understand that this same engine and producer have shown as good results for all day running as 0.76 of a pound of this same pea coal per brake horsepower hour. The engine being rated as 17 b. hp. at 250 r.p.m. is capable of a very large overload when getting as good gas as these indicator cards show. In fact its indicated horsepower will approach 30 and its brake horsepower 24 when its mean effective pressure is 90 lb. per square inch. Abroad it has been customary to rate producer gas engines according to the power developed when the mean effective pressure as shown by the indicator card is 68 lb. per square inch, and it is a question whether there are many authentic tests of any such size producer gas engine running all day with an average mean effective pressure as high as 90 lb. when using anthracite producer coal gas. The compression pressure is moderately high being 185 lb. per square inch.

To understand just how this engine ranks as an economical power producer, it is well to bear in mind that so small a noncondensing steam engine of very highest type would certainly require 6 to 7 lb. of pea coal per brake horsepower hour. So even if we add 20 per cent to the coal consumption reported, this little 9 by 16 in. gas engine performs its work for about 1-7 of the weight of fuel demanded by the same size, high-class, automatic steam engine of the noncondensing type. It has frequently been pointed out that the economic advantages are much more strongly in favor of the suction producer gas engine in small units as compared with any other form of prime mover, than when they are in large units.

Economizers, superheaters, condensers, mechanical stokers and other refinements of detail belong usually to steam engines much exceeding 100 hp. It is remarkable that experience should demonstrate that a 20-hp. gas engine may be substantially as economical in its consumption of fuel as a 500-hp. unit. Seven-tenths of a pound of anthracite pea coal per brake horsepower-hour seems to be as good as a gas engine of any size using the Beau de Rochas cycle has as yet attained.

If cooling tanks are used for the jacket water, such an engine will require for all purposes between 40 and 50 gal. of water an hour. This is much less

than the noncondensing steam engine would require. For lubrication about a pint a day would be a fair allowance. This is rather more than the steam engine would require. Cost of attendance of a gas engine and suction producer will average about ¾ that of a steam engine and boiler plant. These facts permit a power user to size up the elements which go to make up the relative cost of a small gas engine instal-

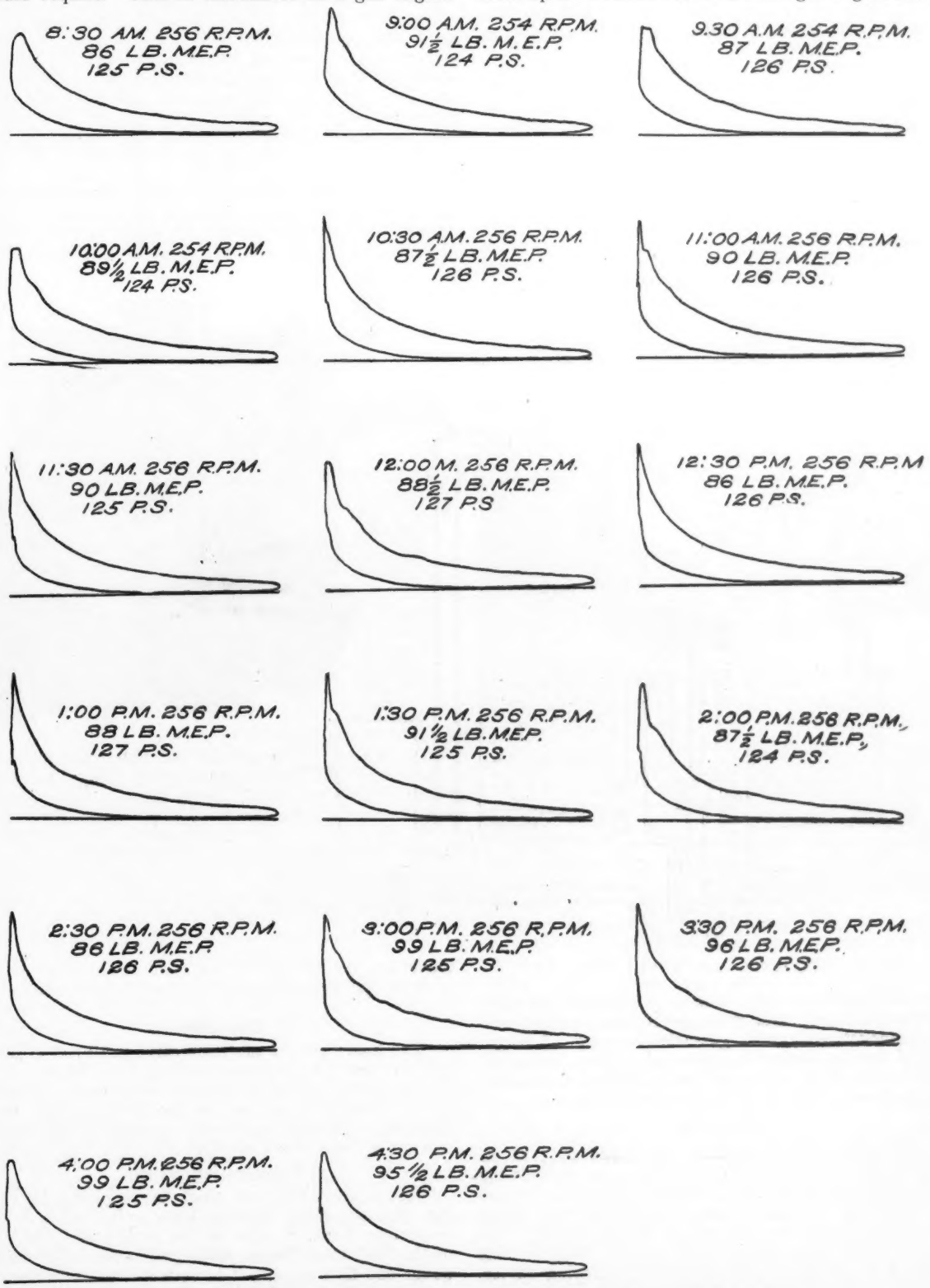


FIG. 2. INDICATOR CARDS TAKEN FROM A PRODUCER GAS ENGINE USING PEA COAL

lation in comparison with a steam engine installation.

Details of the Engine

In Fig. 1 is illustrated a right-hand view, showing clearly the majority of the details of the valve gearing, governor, igniter, piston lubricator, indicator reducing motion and crank-pin lubricator.

The mixing or inlet valve housing is bolted to the top of the explosion chamber and carries a suitable bracket for its rocking lever as well as a guide for its valve-stem. Two helical springs attached to a yoke secured, to the upper end of this valve-stem, insure the rapid seating of the valve.

The outer end of mixing valve rocker engages with the upper end of a push-rod which reciprocates vertically through a long guide. This guide is a part of the cover plate that gives access to the water space of the explosion chamber. Not only does this vertical push rod actuate the inlet valve through its rocking lever, but it also actuates the gas valve as well when the governor permits.

A projecting arm just below the lower end of its guide, engages with another, shorter push rod whose upper end actuates the gas-valve rocking lever. The

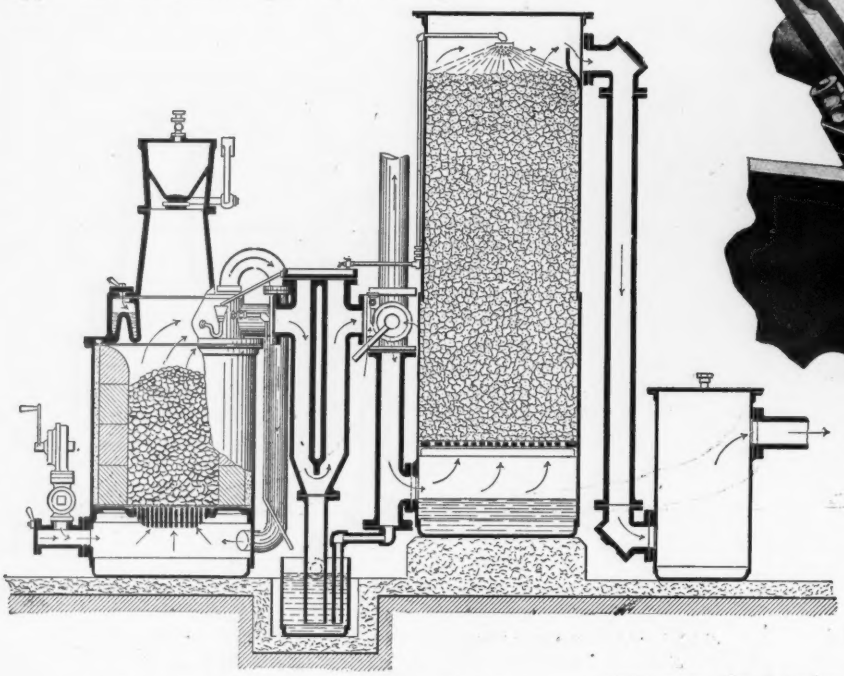


FIG. 3. SECTIONAL VIEW OF THE PRODUCER

stem of this latter valve is seen occupying a horizontal position, and suitably supported at its outer end by a bracket cast on the gas-valve housing. A single helical spring, embracing the valve-stem, serves to reseat this valve with sufficient rapidity, as soon as the pressure of the push rod is withdrawn.

Governor

The system of governing employed is that of cutting out explosions whenever the speed exceeds the predetermined limit. The governor spindle rotates in a horizontal position as may clearly be seen, being spur-gear driven from the end of the cam shaft. The speed of the governor secured by the ratio of this gearing makes it a highly sensitive governing device, though of small size. All the work required is the introduction or removal of the latch that enables the inlet-valve push-rod simultaneously to actuate the gas-valve push-rod, or leave it undisturbed. The less work the governing mechanism needs to perform, the smaller the speed fluctuations need be.

As soon as the actual speed of the engine exceeds the predetermined figure, the rapidly rotating governor balls, moving outward, through the simple system of rods and levers shown, withdraw the latch, and the inlet-valve push-rod fails to actuate the gas-valve push-rod, with the result that the gas valve does not open during that particular suction stroke of the engine, but remains closed the engine sucking in air alone, and not a mixture of air and gas.

On its return stroke the piston compresses air alone which expands on the next stroke, and is then pushed out through the exhaust valve by the piston. It serves one good and useful purpose, however; it

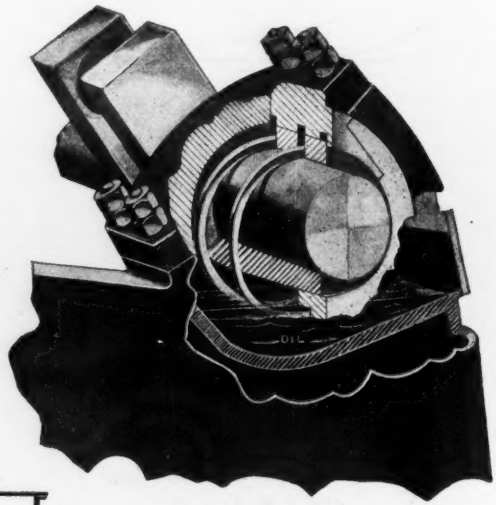


FIG. 4. METHOD EMPLOYED FOR LUBRICATING THE CRANK-SHAFT BEARINGS SHOWING DETAILS OF HOUSING AND BEARING

scavenges the interior of the combustion space clean of burnt gases, and cools the cylinder walls and valve heads.

Cam Shaft

The lower end of the inlet-valve push-rod is actuated by the main admission rocking lever whose roller may be distinguished just behind the governor gearing case. A suitable cam on the cam shaft engages with this roller operating the entire admission valve mechanism once in every 4 strokes.

Compression Relief

Just beyond the cam shaft bearing may be seen the exhaust valve rocking lever roller with a pin projecting from the stud in the lever boss. Because of the high compression employed in normal running, about 200 lb. a sq. in., it is desirable to start the engine with this compression pressure reduced, and for this reason the exhaust cam is made wider than the

exhaust lever roller, and in 1 part of its width is made with an additional cam projection, to insure opening the exhaust valve slightly during the compression stroke.

In starting the engine, the exhaust lever roller is shifted along its stud till it engages with this double cam, and the pin shown is inserted in a suitable hole in the stud to retain the roller in the proper position. As soon as the engine has gathered sufficient speed this retaining pin is withdrawn, the roller is shifted along the stud to its normal position, and the pin inserted in the stud on the other side of the roller.

Ignition

The eccentric adjacent to the exhaust cam operates the magneto, of permanent horse-shoe type, and through its rocking armature connections, the make and break spark plug whose case carries also the pipe

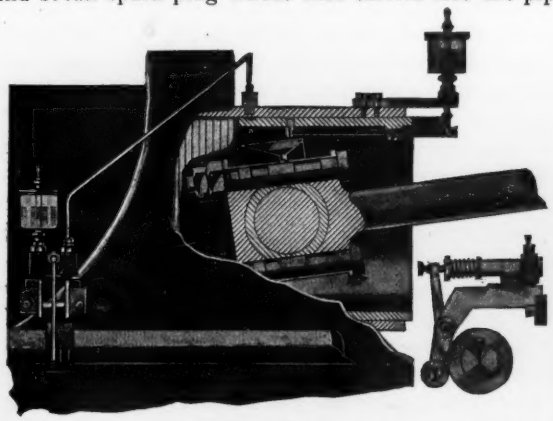


FIG. 5. SYSTEM OF FORCE FEED PISTON LUBRICATION

attachment for the indicator. Full provision is made for the proper timing of the spark, but this detail should not be disturbed when once set right.

Rating

These gas engines are rated according to the brake horsepower developed at the rim of the band wheel when running at the speed specified, the governor cutting out 15 per cent of the total number of possible explosions. This practice assures to the user an overload capacity of 17 per cent.

Theoretically perfect producer gas may have a calorific value of 170 B.t.u., and the producer gas made when cleaning the generator while running may be as low in heat units as blast-furnace gas, 70 B.t.u. so that this method of rating is highly essential.

Lubrication

Figure 4 shows the ring oilers employed on the crank-shaft bearings. This detail is common to the best grade machine design and not only gives perfect lubrication, but utilizes the oil without waste.

The efficient system of forced feed lubrication which supplies just the right amount of oil to the piston at every other revolution of the crank shaft, is shown in Fig. 5. This illustration shows also just how the piston pin or wrist is lubricated continuously.

Another detail of the oiling system is shown in Fig. 7 which is the method of oiling the crank pin and has given excellent satisfaction under the most exacting and trying conditions as to speed and also pressure transmitted.

Gas Producer

A complete suction gas producer installation, including generator, separator, drain tank, scrubber, gas tank and hand blower for blowing up the fire at starting, is shown in the sectional view, Fig. 3. The vaporizer is a hollow annular casting bolted by its flange to the steel shell of the generator proper. Through its center pass all the hot gases distilled from the coal on their way to the separator, and from its interior comes the water saturated air that is to take part in the production of gas.

The down-comer pipe that delivers this mixture of steam and air to the under side of the fire grate is shown on the right of the generator. Immediately beside this pipe is seen the separator, connecting through the vaporizer with the upper part of the generator on one side, and through a down-comer pipe

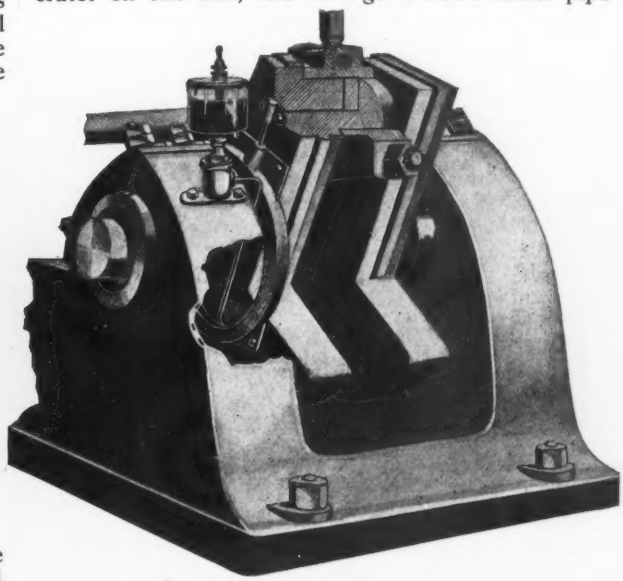


FIG. 6. CRANK PIN LUBRICATING DEVICE

with the scrubber on the other side, a 3-way valve permitting the passage of the hot gases either to the scrubber by the down-comer pipe, or by the purge pipe to the outer air. This purge pipe is in line with the down-comer pipe, and extends vertically some 30 ft. to insure a proper draft when the engine is not working.

The lower part of the separator enters the drain-tank, and in this receptacle are deposited many of the small particles carried over from the generator by the gas.

In the scrubber the course of the cooling water is from above downward, while the course of the gas is from below upward. The scrubber is filled with coke, larger pieces being placed in the lower part, and the smallest pieces on top. A continuous flow of cooling water, supplied by the small pipe shown alongside the scrubber, trickles down continuously over the coke in the scrubber, washing down the dirt deposited in the upper layers, till it finally accumulates in the botton where it can be drawn off periodically.

The height of the scrubber is such that the gas in its passage from the bottom to the top is cooled to nearly the temperature of the scrubber water when it leaves the sprinkler. From the upper part of the scrubber, through a final down-comer pipe the now cooled and cleaned gas passes into the gas tank.

These gas engines and producers are the product of the New York Engine Co. and show a noteworthy advance in producer gas engine operation.

PRACTICAL ENGINEER

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POWER COSTS

In an address before the Ohio Society of Mechanical, Electrical and Steam Engineers, the president, F. W. Ballard, takes up the question of power cost for factories and gives a most interesting discussion, not only of what costs may properly be, but also of how to keep track of costs so as to determine whether one's plant is doing reasonably well or not.

As regards the comparative cost between steam and gas engine plants, the fuel cost in the producer gas plant will usually be higher per ton of fuel used, as the bituminous producer up to the present time has not proved in all respects an unmitigated success, and when using anthracite, if the poorer grades are used, it is usually found that the extra cost of attendance more than makes up for the saving in fuel. On the other hand the steam plant, when rightly designed and handled, can use almost anything that will burn at all.

Mr. Ballard states that with the highest type of steam plant a horsepower-hour can be secured for about 20,000 heat units, while with the ordinary gas engine it can be secured for from 9,000 to 10,000 heat units, but the cost of a heat unit ready to put into the engine cylinder is considerably greater in the case of the gas engine plant than for the steam engine. The steam engine has the added advantage that the exhaust can be used for heating buildings or for industrial purposes, but the gas engine is also being adapted for such use by means of economizers and other feedwater heating systems.

As to finding out what the costs actually are in a plant, he states that all plants must depend on comparison of costs under different conditions of running. In order to get the reports the first thing is to determine what we want to find out from the reports, and then have the report blanks made to give this information. The next step must be the careful keeping of accurate reports, and the third the careful comparison of these reports from time to time to see what differences exist and how these differences have been brought about.

In his own comparisons he has separated entirely the matters of power generation and transmission, because it is easier to get from other plants costs of power at the switchboard with which to make comparison; second, because the cost per kilowatt-hour at the switchboard depends on the power plant, while the cost of power transmission depends often on the master mechanic of the works or the superintendent and by separating these 2 costs the results of changes in different departments can more readily be studied.

The whole paper points plainly to the doctrine often preached in these columns, that in order to know whether one is doing well or ill in his plant, records must be carefully kept and carefully studied, that as no person can predict in advance exactly what effect on the total plant economy may be produced by changes in method of operation the right way, for in-

stance, as to methods of firing of the fuel in use, is to try different methods and note the result produced. In this way wasteful methods and apparatus can gradually be weeded out and the plant brought to the highest possible efficiency.

BOILER ROOM MANAGEMENT

Among the thousands of readers of Practical Engineer there are many who are directly in charge of boiler plants and who are interested in proper methods of handling such installations. In connection with the great amount of information on fuels and furnaces which we propose to give our readers, we believe that a good description of such methods from the men who are actually doing the work will be of the greatest value.

We therefore invite and urge each of you who are handling boilers to send us data in regard to your plant and the method of handling it, results obtained as to fuel consumption, smokiness or smokelessness, steam consumption, or engine horsepower delivered and so on. We would suggest that these descriptions should include the kind, capacity and number of boilers and furnaces installed, the kind of coal used and amount used per day, number of firemen employed, how the fires are handled, what method is used to check up as to the correctness of this firing, the output of the plant in steam generated or horsepower output, smokiness of the chimney, height and diameter of the chimney and any figures possible in regard to the cost of fuel, labor, etc., pertaining to the plant.

Data in regard to purification of the feed water by softening, steam heating and use of boiler compound, etc., with the results, frequency of blowing down and other matters in regard to the cleaning of the boiler would also be of interest. We would urge that this data be submitted as soon as possible in order that it can be looked over and put in shape for the Fuels and Furnaces issue.

Remember that it is for the interest of you all that we are asking this and you will reap the benefit of whatever results or conclusions come from the work.

EDITORIAL CHAT

The Latest in Flyers

Flying machines are still improving and justifying the prediction that those which have seemingly made such success during the past summer are really in the experimental stage as compared with what the final developments will be.

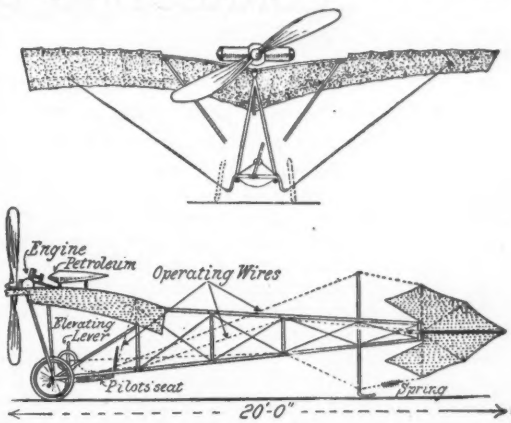
The Wright machine, which has shown itself in many ways the best flyer of the lot, has recently been much improved by taking one of the horizontal steering planes from in front of the machine and putting it in back, thus giving a much steadier machine.

The newest comer into the field is almost a pigmy as compared to the older ones. It is the invention of Santos Dumont, has a spread of wings of 18 ft., and overall length of 20 ft., and a height of 4 ft. 2 in.

To use an automobile simile, it is distinctly a runabout, although it carries about as much weight as some of the heavier types. The total weight of the machine is 242 lb. and the engine which is 2-cylinder, opposed, weighs 110 lb. With passenger aboard the total weight is 3.6 lb per foot of supporting plane.

The frame work is of bamboo, a reasonable kind of a proposition, considering the use and strength of this remarkable material. The main frame is put together with brass sockets much like a fish pole, so that it is possible to make a dismountable construction which can be packed into small space for shipment.

The engine is of extremely light weight with brass water jackets, the flow and exhaust valves being me-



THE DUMONT MONOPLANE (SCIENTIFIC AMERICAN)

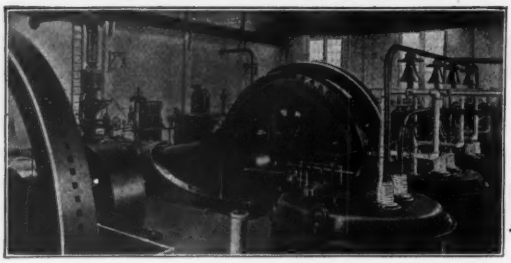
chanically operated and placed in the cylinder heads, the propeller being carried directly on the crank shaft in the front of the machine. Cooling is effected by a geared water pump mounted on the rear end of an inclined shaft. This shaft has the pump gear at the lower end, the magneto at the upper end, and the driving gear near the center. The carburetor is at the rear of the motor supported from a torpedo shaped gasoline tank, while a larger fuel tank is located beneath the plane behind the driver.

Radiators for cooling the water are of thin copper tubes, ⅛ in. in diameter, running from front to rear of the main plane on the under side. Water from the cylinder jackets passes out from the upper sides of the cylinders through inclined pipes to a small wedged shaped tank from which it descends to the bottom of the radiators at the rear edge of the plane. Here the pump forces it through the radiator tubes to heads at the front edge of the plane and from these heads it goes to the bottoms of the water jackets.

Cylinders of the motor are 4.118 in. bore and 4.724 in stroke. They run at 1800 r. p. m., giving the 6.5 ft. propeller a thrust of 242.5 lb., when the machine is stationary.

Other details are clearly shown by the illustrations. Santos Dumont proposes to permit the use of this design by anyone who desires it and a firm in France is now putting them on the market at a price of $1200 to $1500.

ELECTRICAL MACHINERY AND APPARATUS



CORRECTING DYNAMO TROUBLES

By W. H. Coles

ELECTRICAL machinery, even though it has been largely shrouded in mystery, is, nevertheless, comparatively simple in its operation and maintenance. To a considerable degree it is mechanism, and cannot be handled with the same treatment one would expect to give a crowbar. But there are a few underlying principles which govern such dynamos as are ordinarily used in small isolated plants, which, if they are observed, will enable practically any operator to maintain and keep in perfect running condition any well constructed machine.

In the first place, it is safe to assume that any dynamo purchased from a reputable manufacturer leaves his factory in good condition, because every dependable manufacturer tests out each machine very thoroughly before its shipment; in fact, any policy other than this would be suicidal to the building up or maintaining of a permanent business.

A dynamo received from such a manufacturer should be carefully examined to see if it is in apparently good condition, or whether it shows evidence of having been injured by rough handling in transit. If this inspection points to its having arrived in good condition, its installation should be considered in a general way along the lines similar to those which would be observed for the installation of any piece of machinery.

Mechanical Precaution

Care should be taken to see that the bearings are properly supplied with oil; that the dynamo stands perfectly level on its foundation; that the belt is of good quality and free from bumps or improper lacing. It may be noted that the dynamo does not necessarily require an independent foundation, which is demanded by some classes of apparatus. Because of the fact that its vibration is very slight, any rigid or substantial floor will answer for this purpose.

In starting up a direct-current dynamo, only two things which might be termed "electrical" need be specially considered. The first is the direction of rotation, because each dynamo as shipped from the factory is so connected as to run in only one direction and will not generate current if the direction of rotation is reversed.

It is an easy matter to change the connections on a machine so that a reversed direction is possible, and a sheet of instructions furnished with the dynamo usually covers instructions for this modification, but it should be remembered that each dynamo as received by the user is so connected as to operate in only one direction.

The second vital consideration is the speed of the dynamo, which should not be less than the speed given on the name plate nor greater than ten per cent above the speed. A slower speed would interfere with the building up of the voltage, while a higher speed would deliver an excessive current from the machine. It is needless to add that the directions for wiring connections furnished with the dynamo should be followed carefully.

Loss of Voltage

If, after a dynamo has once been running satisfactorily, there occurs some difficulty in its operation, the probability is that, unless the occasion of the trouble is due to some mechanical injury or to the dynamo's having become saturated with water or oil, the nature of the trouble will most frequently manifest itself in one or two ways. The first is that the dynamo will refuse to generate current, and the second is that sparking will show itself between the commutator and the brushes.

Under this latter head, it is worth remembering that the heating of a dynamo is generally due to some cause which, if it existed to a greater degree, would manifest itself in sparking, so that many times the heating of the machine means that trouble exists to a limited extent, which if it occurred in a greater degree would manifest itself in sparking. A common exception, however, to this statement is that the brushes if pressing too firmly on the commutator, will from their friction produce heat.

If on starting a dynamo, after its use has been discontinued for a time, it refuses to generate, which means that the operator is unable to secure electricity from it, he should first assure himself that the machine is operating at its proper speed and that there has been no speed reduction, due either to a slowing up of the motive power or to a slippage of the belt.

If no such difficulty appears, the next investigation should determine as to whether or not the resistance of the rheostat remains in the field circuit. Dynamos can frequently be made to generate by simply moving the handle of the rheostat to the point marked "highest voltage."

The third and possibly most common cause of failure of a dynamo to generate is due to a defective contact between the commutator and the brushes. This may be caused by a lack of proper tension on the brushes, due either to their being too weak or their need of re-adjustment. Again the brushes and holders may have become dirty and gummy, preventing their proper action. An excessive amount of grease or dirt

on the commutator occasionally, (especially in cold weather) forms a scum over its surface which intervenes between it and the brushes, retarding the flow of the current.

Loose connection may exist in the wire leading from the brushes to the lead post. However, the operator can look intelligently for the trouble when he realizes that the early current generated when the dynamo begins to operate is of slight intensity and obstacles which would not interfere with the flow of the current of ordinary proportions will retard the flow of this initial current, consequently a very slight resistance or hindrance may prevent the dynamo from generating.

Sparking

This brings us up to the general manifestation of trouble, namely, sparking at the commutator, which is the most frequent difficulty encountered in a dynamo. A small red spark, which can be easily recognized as occasioned by dirt, is not seriously injurious, and a cleaning of the commutator and brushes will overcome it. But, a vicious, spitting spark will, in the course of a comparatively brief time, materially injure the dynamo, and when first detected, steps should be taken to overcome it without delay.

Briefly indicating the causes of sparking which do not permit of ready classification, it may be possibly occasioned by an excessive overload on the machine, due to a leakage in the wiring or to the use of too many lights. If this is responsible for the sparking the machine will heat materially in all its parts.

Open Circuit

It may be true that an open circuit or a break in the wiring of the armature may exist. In this instance the spark will be very vicious and an examination of the commutator will show that it has been burned on one of the mica lines across its surface. An open circuit in one of the fields may also result in sparking, but this can be determined by an unequal heating of the fields.

Bad Brush Contact

Coming to the 2 most common causes of sparking: the first lies in the fact that the contact between the commutator and the brushes may not be firm and uniform. The commutator itself may be rough, or the bearing surface of the brushes may be irregular; roughness of the commutator resulting occasionally by its having been burned down or worn. Occasionally the copper wears more rapidly than the mica, leaving the mica projecting upon the surface of the commutator. If the commutator is rough, a piece of No. 2 sandpaper held firmly on its surface while it is in operation will overcome minor irregularities. If this does not correct the trouble, the armature should be taken to a first class machine shop and the commutator turned off in a lathe.

Truing Brush Contact

If the brushes are so worn that they do not fit snugly on the commutator, fasten a strip of No. 2 sandpaper around the face of the commutator, the sand side out; then revolve the commutator with this strip of sandpaper attached to it until the bearing surface of the brushes will be trued up, insuring a perfect contact. Strange as it may seem, the most common cause of sparking, occasioned by an improper contact, lies in the fact that the user does not recognize that carbon brushes wear out and occasionally need to be replaced. Frequently machines are sent back to the manufacturer for repairs when the only occasion of the trouble is that the carbon brushes have been worn until they cannot rest firmly on the commutator. When the brushes become so worn that it is difficult with the mechanism of the holder to secure a firm pressure against the commutator, they should be replaced with new and longer brushes.

Setting Brushes

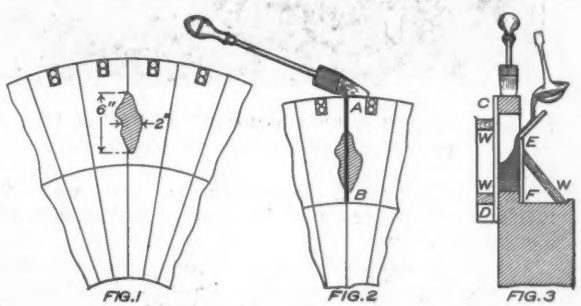
The brushes may have been shifted out of their proper position in reference to each other and to the commutator. On machines which have 2 field coils the brushes should rest on the commutator at points which are directly opposite to each other. On machines which have 2 field coils these points should be exactly 90 deg. apart. If the brushes are properly spaced in reference to each other, then their correct position on the commutator becomes a matter of locating what is known as the "neutral point."

In order to locate this neutral point, move the rocker arm which carries all the brushes around with the direction of rotation, while the machine is in operation, and carrying a comparatively light load. Do this until a slight spark appears, then move the rocker arm back in the opposite direction just enough to stop the sparking; this will be the neutral point.

The general rules of keeping a piece of machinery dry, clean and properly oiled should be observed with a dynamo.—Gas Review.

REPAIRING A DAMAGED COMMUTATOR

A method of repairing a large hole which was burned in 2 adjacent bars of a commutator, the intervening mica being pierced and destroyed by the arc set up, is described as follows in Feilden's Magazine. Fig. 1 shows the general shape and dimensions of the hole. The first operation was to clean carefully and tin the surface of the hole. The 2 bars were then



METHOD OF REPAIRING A COMMUTATOR

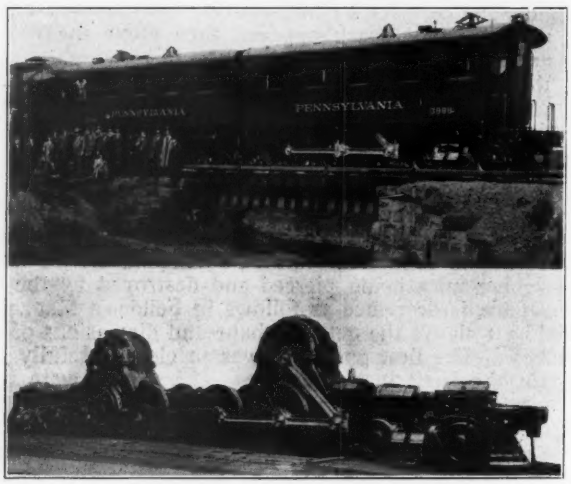
wedged apart and mica strips, A B, of the requisite size and thickness forced in. The commutator was then warmed up as much as possible by means of soldering irons, and strips of mica, C D, E F, placed at the front and back of the hole, being kept in position by pieces of wood, W. Solder was then poured into the hole from a ladle, using a rough mica funnel to guide it. This method proved to be a thoroughly good mechanical and electrical one, and saved the time and cost of dismantling the commutator entirely and fitting new bars. The details of the operation are shown by Figs. 2 and 3.

WHEN THE DAY'S WORK has been done like a whole man and each golden moment has carried its full burden of usefulness, we go "to our resting beds, weary it may be but content"; and if we have "played the man" in all things we come undishonored before the court of conscience to receive the gift of sleep.

PENNSYLVANIA ELECTRIC LOCOMOTIVES

The first "Pennsylvania" type of electric locomotive has been finished, and given its first test on the Long Island Railroad. It weighs 330,000 lb., and will develop 4,000 horsepower—about 3 times as much as a giant freight locomotive—and can pull a heavy freight train at a speed of some 60 or 70 miles an hour. In appearance, it is similar to 2 passenger coaches, with huge driving wheels and rods, roofed by steel cabins which conceal the giant motors with which the driving rods connect, but a view of the chassis gives an excellent idea of the intricacy of the machines which are soon to haul some 1,000 trains in and out of New York Station every day.

The first twenty-four electric locomotives to be built for service in the New York Tunnels will be assembled at Altoona, Pa., where the railroad company's shops are located. The electric apparatus is to be built at the East Pittsburgh shops of the West-



PENNSYLVANIA ELECTRIC LOCOMOTIVE AND ITS CHASSIS, TO BE USED IN THE NEW YORK TUNNELS

inghouse Electric & Manufacturing Co., while the mechanical features will be made in the railroad's locomotive shops.

The "Pennsylvania" type locomotive is built in two sections, each section having 8 wheels, 4 of which are drivers, 68 in. diameter, the other 4 being truck wheels 36 in. diameter, constituting in their arrangement and weight distribution what in steam locomotives is called the "American" type.

Two pairs of drive wheels are coupled not to the customary crosshead and pistons, but to a crank shaft, called a jack shaft, in line with the driver axles, which in turn is coupled to a motor crank shaft, to which a single motor delivers all its power. The cranks are 90 deg. apart, so there can be no "on-centre" position. The motor crank revolves uniformly and at constant effort, differing therein from steam practice, and while the pressures on the connecting pins and rods vary throughout each revolution, the turning effort of the drive wheels is the same as for the motor, constant throughout each revolution.

A decided improvement in the "Pennsylvania" type is the use of a single motor for 2 pairs of drivers, and the benefits secured by its position. The motor is located high up from the roadbed, secure from snow, dirt and water, and space limitations are largely removed. In its design it possesses electrical features never before secured on an electric locomotive.

The single motor weighs, without gear, 45,000 lb., and in weight and power it is the largest railway motor ever constructed. It projects into the cab and, in fact, fills a large part of it.

In the operating end of the locomotive there is a Westinghouse brake valve for high-speed brake operation, and also the engineer's controller, by which all electrical manipulation is secured. These correspond to the throttle and reverse lever on a steam locomotive.

The first 24 Pennsylvania type electric locomotives to be built will have the following dimensions: Total weight of mechanical parts, 103 tons; total horsepower, 4,000; maximum draw bar pull, 60,000 lb.; maximum speed, 60 to 70 miles an hour under load.

MASSACHUSETTS QUESTIONS FOR THIRD CLASS ENGINEERS' LICENSE

1. When an engine is on center, how can you tell which way the valve is opened?
2. How do you take up the connecting rod and how would you lengthen it when it is on the head end? How when on the crank end?
3. If, on taking charge of a plant, you found the connecting rod too short and had to start up at once without being able to shut down for any length of time, what would you do if the keys were driven down as far as they would go, or if they would go clear through the slot and there was no time to have a new connecting rod made?
4. When taking charge of a new plant if you went into the engine room in the morning, how could you find the clearance without turning the engine over or moving the crosshead and without disconnecting the rod?
5. If the key was driven down as far as it could go and lost motion must be taken up, what would you do, not being able to shut the plant down to have a new key made?
6. What is the object of boring the cylinder?
7. After the Sunday shutdown, when you enter the plant Monday morning, how can you tell whether your main steam pipe from boiler to engine is full of water or not?
8. If you have a duplex pump with one piston at one end of the stroke and the other one at the other end, how can you tell which piston will start up first when steam is turned on?
9. What is an outside packed plunger pump?

Fireman.

A NEW LUMINANT

A British citizen has invented a petrol-air gas which it is claimed will save from 50 to 75 per cent on gas bills.

The gas is made by mixing with air a small proportion of petrol vapor. Applied to special burners it burns with great power and gives off sufficient heat to be serviceable for cooking, heating or lighting.

This gas costs 24 cents a thousand cubic feet to produce, so that a 125 candlepower burner when in use costs 1/5 cent an hour and will light a large room. For the cost of 2 cents enough gas can be supplied for 8 hr. to a radiator capable of heating an ordinary room.

The mechanism which makes the gas is small, compact, and simple to work, and a producing plant capable of supplying 25 lights can be made for about $100.

GIVE YOUR BEST to whatever you are doing now and it will develop a greater possibility just ahead.

HOW THE NEW CHIEF MADE GOOD

MAKING PROGRESS AND MAKING PLANS

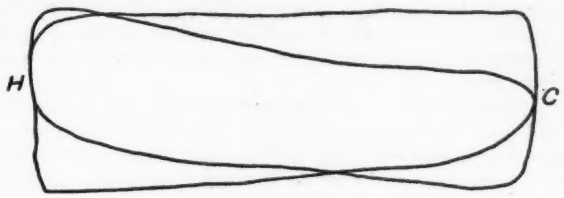
By George H. Wallace

WHAT in—are you sitting there and doing nothing for! Haven't you got anything else to do?' ' Bellowed John Gautelbeim one day as he slipped into the engine room where the new chief, George Willard made his headquarters, and discovered that industrious person sitting before his desk, looking over a few books and catalogs.

Not receiving the recognition that he felt was due him, John Gautelbeim, the manager with the boomerang grouch, roared again in tones that would drown a 4-in. pop valve, "Hi there, didn't you hear me speak to you? I want to know why you don't get up off that chair and do something! If you can't find anything else to do but putter over a lot of useless books, go out and wheel in coal! I can't afford to have a man drawing $125 a month sitting around in an easy chair and reading all day!"

Willard paid not the least attention.

"Hi there, you—You——YOU————" as he shook the chief by the shoulder, and at the same time choking with indignation, "I'm talking!"



THE FIRST DIAGRAM FROM FRITZ'S ENGINE

"Oh, I beg pardon Mr. Gautelbeim, were you?" said Willard in feigned suprise as he looked up. "Well, what did you say?"

Gautelbeim reiterated his assertion as set forth, throwing a liberal mixture of profanity for good measure. As he finished his insane tirade, Willard arose and looking the manager square in the eye said:

"Mr. Gautelbeim, I will not tolerate any such remarks as that from any man connected with this plant in any capacity. I have been hired by your superintendent for a purpose. The fact that I am one of your employes does not for a moment give you a license to address any such miscellaneous remarks to me; and if you think for an instant that you are losing money on me, write out a check in my favor for $1,500 for a year's salary, and I will step out!"

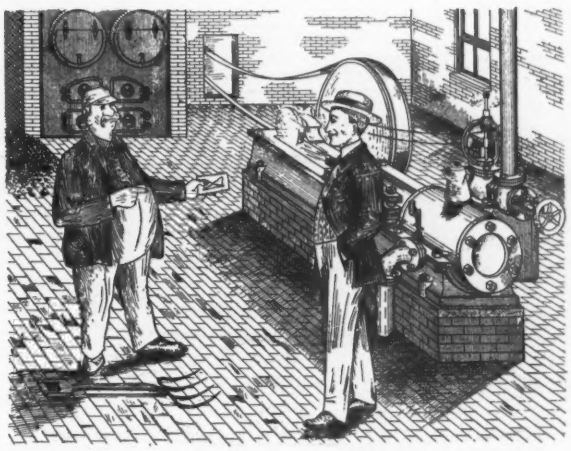
Mention of the check reminded the manager of his first encounter with the chief, and it served to ruffle his temper still more until his wrath breaking all bounds flared out in a demoniacal demonstration. After some time Willard rose, sauntered toward the door and, in his usual quiet firm tone of voice, said, "Mr. Gautelbeim." The latter paused.

"Come here." He came. "Let's go outside to cool off." And he followed as Willard led the way out of doors.

"This is a very beautiful day out, is it not, Mr. Gautelbeim?" said Willard, as he turned on his heel and re-entered the engine room to his books, leaving the astonished manager outside alone, dumfounded and bewildered. Finally he took the hint and returned to the office.

"Dot iss nottings Misser Villard ven you gets juiced to it," said Fritz the engineer of this particular engine, (who had been a witness of the verbal fireworks) as he set a battered oil can down on the box bed of the engine. "Sometimes ole Yon he comes in efery day tree, four times and sometimes vonst, und he raise so much hell mit us fellers dat ve don't tink nottings apoud it some more. Ve chust say nottings, und saw vood," and Fritz chuckled gleefully to himself, spat on his hands and grabbing the big fork proceeded to generate more steam with the shavings that had formerly gone down the river.

Willard could not help laughing, both at Fritz and at the discomfort of the "old man." Then he turned to his desk again and took up the interrupted task of



"S-A-Y, DOT AIN'T NO MONEYS"

selecting some material which was badly needed, and which task was interfered with when Gautelheim stormed in.

Having completed the work in hand he opened the bottom drawer of his desk and lifted out a rosewood box containing his pride and his joy—an indicating outfit. More out of curiosity than anything else he asked his engineer.

"Fritz, do you know what that is?"

"Dot? Vy-m-m; dot looks like von apple parer vot mine frau have got, aber Katrinas vos not got such-as-a shiny pizness all over und not has got so much-as-a strings und shprings like von clock. Vos ist es?"

"That, Fritz, is an indicator."

"Ish dot so! Vy, I don't tink it looks like a incubator a little bits. Hat ole Yon Gootelbeim diser gekaufen, yes, no? No——o—o!"

"No. He did not buy it. This is one of the many things Mr. Gautelbeim has no use for."

"Yah, und you wos anodder," chuckled Fritz as he went back to his shaving bin.

Between fires he assisted his chief in attaching the instrument to the indicator piping, which had for 25 yr. done no other service than to keep a badly battered coffeepot full of alleged cylinder oil from falling to the floor.

When finally in place and adjusted, Willard deftly

hooked the string over the top of an oil cup on the crosshead shoe, which was most conveniently in line, and took the card shown in Fig. 1. As he removed the card Fritz's eyes opened in astonishment.

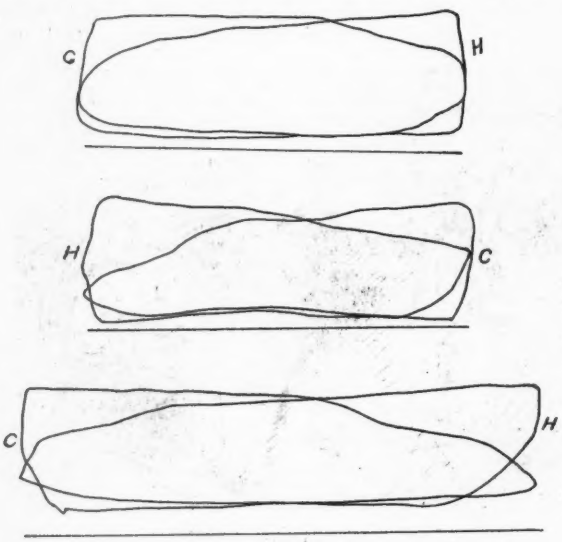
Ah—ach! du liber! vot is dot? Von of doze moving pictures machines already?"

"Well, yes, Fritz, that's a picture of Gautelheim's profits gone to glory and also the raise in wages that the men ought to have."

"Gif it to me kvick," said Fritz as he grabbed the card and studied it for a while—upside down. "S-a-y, dot aint no moneys Misser Villard" almost with tears in his eyes.

"Well, it amounts to the same thing, Fritz," said Willard, and he explained both instrument and card briefly to the unlearned engineer whose astonishment was intense.

The remainder of the day was spent in indicating three of the remaining engines of the scattered power



"PICTURES OF GAUTELBEIMS PROFITS GONE TO GLORY"

plant and the cards shown in Figs. 2, 3 and 4 were secured, all showing that, when Gautelbeim bought "just what he wanted" cheap, he eventually "paid the freight."

With these cards in hand the chief returned to his desk and studied them over. While thus engaged Superintendent Mather came in and together they discussed and perfected ways to keep the wheels going, keep more of them going, keep them going for less money and keep them going till the new power house was ready.

The principal topic under discussion was whether or not it would pay to make any more changes, improvements or repairs on the present scattered power equipment inasmuch as it would all be discarded inside of a year, or 2 at the farthest.

"Of course Mr. Willard," said the superintendent, "if you can spend some money and get it back again before we throw the old engines and boilers in the scrap you have my support. Those old engines certainly are everlastingly hungry for steam, and steam is coal and coal is money and money is profit and loss. Now, if, as you say, you can by redesigning the valves of those old engines, reduce this appetite and save fuel enough to pay for the change in, say, 1 year, you are making money for Baum & Gautelbeim."

"Yes sir, Mr. Mather," said the chief with confidence. "I am convinced that the saving in fuel will pay for the proposed change in not to exceed 3 months at the outside. At present the temperature of the gases in the breech of the boiler is anywhere from 800 to 1200 deg. F. My proposed change in design will cut the steam off earlier in the stroke, expand it down to but little above the atmospheric line and thus do more work with the same steam or rather, do the same work with less steam than at present. Thus it will not be necessary to force the boilers so that the temperature of the waste gases will be, say, only half as high.

"Now, next Sunday," continued the chief, "I propose to examine the valves of as many of our antiquated engines as I can, take the necessary data regarding valve travel, port opening, etc. I will then design a valve for each engine, that will do the work more economically and as fast as the sketches are completed, will send them to the pattern shop, foundry and machine shop in order. We ought to have at least 1, maybe 2 ready to put in the following Sunday, and when all are in, we can then begin to save Baum & Gautelbeim a little more money. They don't appreciate it, I know, but there is a certain pride in knowing that you have done the right thing, whether any one else believes in it or not."

The next Sunday, the various slide valves were examined and found to be short on lap and long on port opening. The necessary information having been secured, the engines were made ready to carry the load during the coming week, in the same extravagant manner that had characterized their existence up to that time.

Monday afternoon the first sketch was completed and sent to the pattern shop. Tuesday saw another and Wednesday 2 more, and by that time, the first one had been cast and sent to the machine shop, where it was finished and scraped on a surface plate.

On the next Sunday (the engineer has no Sunday when the plant calls) the first of the new valves was fitted to place and adjusted and the engine started up to see how it worked. The moment the first card was secured, the light began to shine in the brown eyes of the new chief, and he and the superintendent decided that they were traveling in the right direction to save a little money towards buying a new power plant.

The close of that month saw 4 old engines with new valves designed to cut off steam at a more economical point than before, and secure a lower terminal pressure. One of these valve seats required planing, but a little portable shaper borrowed from the machine shop and operated by a motor, did a quick and neat job of it.

A few weeks later John Gautelheim opened the door of Fritz's engine room very cautiously and finding that the chief was absent, walked in and looked around carefully.

"Fritz, about how many tons of coal a day are you burning now?" he asked guardedly.

"Oh—, tree, four hunnert, maybe," replied Fritz.

"Three or four hundred tons of coal a day!" roared John in surprise.

"No,—pounds."

"Oh!" very quietly. Then continued, "Why is that, Fritz?"

"Dos veis ich nicht aber Herr Villard makes some new iron pizness for in heyah" (rapping the steam chest with the monkey wrench) "und now ve sometimes have got shavings enough to do all day; sometimes I gets a few veelbarrows full of coal; dot's all!" and he shrugged his shoulders, cocked his head to one

side and thrust his hands forward, palms upwards, to add emphasis to his statement.

Visits to the other engine rooms revealed the same state of affairs: money being saved everywhere. Even the time-honored cracks in the brick setting had been plastered up! This little tour of inspection had done more to tame the ungovernable spirit of John Gautelbeim than a year of bitter strife and overwhelming opposition would have done.

With his hands thrust deep in his pockets, and his head bent forward, he retraced his steps to the office, went to his sanctum sanctorum and closed the door.

"I'VE BEEN A PIGHEADED FOOL!"

For perhaps one hour he sat there, thinking, scheming, meditating. As the soft glow of the Nernst lamp overhead proclaimed the close of an autumn day, he arose, pulled down the cover of his roll top desk, and strode out through the deserted office. He pulled the heavy oaken door after him, buttoning up his ulster as he passed down the granite steps. An enterprising newsboy hustling past with his bundle of evening papers was startled into silence as he heard Gautelbeim exclaim between his clenched teeth,

"I've been a pig-headed fool!"

TWO METHODS OF FASTENING LEATHER ON IRON PULLEYS

The first of these given by E. B. Gaskey says: Soak 6 lb. of glue over night, then heat until thoroughly dissolved, and add 6 lb. of white lead ground in oil. Add oil until the mixture is of free working consistency; then add 1 oz. of nitric acid and stir until thoroughly mixed. The pulley surface should be thoroughly cleaned and warmed to about 125 deg. F.; the cement is then applied and leather clamped on and let stand 12 hr. before using.

The second method, given by R. F. Williams in Machinery, is as follows: First soak 12 oz. of good glue in cold water, then put 4 oz. of boiled oil and 4 oz. of turpentine into the glue-pot and in this dissolve 3 oz. of resin. When the resin is dissolved, add the glue, the resin and glue being well stirred while dissolving. The surfaces of leather and pulley should be perfectly clean, then with a cloth apply full strength muriatic acid on all parts of the face of the pulley, and when dry, wipe it gently away.

Have the cement which has been melted in the glue pot applied across the face of the pulley with a brush for about 6 or 8 in. Lay on the end of the leather and rub it down hard with the corner of a piece of wood. Fold back the leather and apply another length of cement, then rub the leather down on that and so continue until the pulley is covered. Two thicknesses of leather should be used, the first being made with a butt joint and the second with a scarf or lap joint of about 4 in. in length, making the lap the way the pulleys are to run for driven pulleys and for drivers in the opposite direction.

THE DEVIL OF DEBT

The devil of debt seems to be on the heels of almost everybody. The clerk, he's in debt. The bookkeeper's in debt. Ditto the typewriter. Same with the porter and drayman. As for the superintendent, he can't remember when he wasn't. The office boy would be in debt if anybody would trust him. And all of them complaining and acknowledging the miserableness of their condition.

Debt is a mortgage on your salary.

Debt is a monument to a young man's weakness, a grown man's folly and an old man's failure in the university of life.

Debt is discounting tomorrow's liberty for today's good time.

Debt is a quitclaim to your wife's confidence, your children's ambitions and your own self respect.

Debt is a guaranteed insurance policy against happiness.

"Then what are we going to do?" say a chorus of young fellows and business men and aspiring women and laborers and clerks and managers and street car conductors and hundreds more.

Do without!

It will take some backbone. It will take some genuine courage.

But you'll be able to hold your head up—and that's more than you can do now, and you know it. You won't have palpitation of the heart when the postman blows his whistle, and you won't tremble every time the boss asks you to come into the front office. Neither will you be ashamed to have your stenographer open your mail.

Because you'll be working today for tomorrow's satisfaction, and not to make good on account of yesterday's extravagance.—Pittsburg Press.

THERE IS SOMETHING FASCINATING for engineers in the story told by the International Acheson Graphite Co. of Niagara Falls, N. Y., that "we are the only makers of graphite in the world." The information advanced by this statement will open the eyes of engineers to new possibilities in the application of graphite, now that science has come to their assistance and given them graphite free from natural impurities. The International Acheson Graphite Co. has 2 products of great interest to every power plant. These products are Graphited Greases and Acheson-Graphite, Grade 1340. Their 1340 graphite is a very fine, soft, unctuous product, guaranteed at least 99 per cent pure. It is not tough, but has the spreading qualities so necessary to ideal lubrication. This graphite can be used in powder form, as it is a perfect lubricant in itself, or it can be mixed with grease or oil, affording ideal lubrication in either form. It is this graphite, claimed to be the very best in the world, that this company blends with a high grade grease in the manufacture of its Graphited Greases, products which it is claimed easily set the standards for grease lubricants.

OPERATION AND MANAGEMENT OF AN ABSORPTION PLANT

By Charles L. Hubbard

IN a general way the care of an absorption plant is similar to that of a compression plant; cleanliness of the various cooling surfaces being an important point in both cases.

Fluctuation of the liquor in the absorber gage glass is usually caused by air or some uncondensable gas in the system, and can be remedied by opening the purge valve and allowing it to escape.

Height of Liquor

It is customary to carry the level of the liquor in the generator at about the center of the gage glass. Some machines work better if the upper pipes of the steam coils are exposed, as the rich liquor falling on the hot pipes generates gas more quickly than when they are submerged. This however is not good practice as the pipes deteriorate rapidly under these conditions.

If, after running for some time the liquor in the condenser gets low, and still persists in doing this after being refilled, the cooling water in the various coils and the brine should be tested for ammonia, to see if any leaks exist. If this test fails to give a reason for the condition, the anhydrous liquid from the condenser should be tested to determine whether it contains more than 5 per cent of moisture, as a greater amount would indicate that considerable liquor was lying in the bath coils.

This test can be made by carefully drawing off a small amount of the liquid and allowing the ammonia to evaporate, measuring the amount before evaporation, and the quantity of water remaining afterward.

If this test shows the moisture to be less than 5 per cent it means that the rectifier is doing its work properly at the present time, but that probably a quantity of liquor is still lying in the bottom of the evaporating coils. This can be drawn into the absorber by first allowing the liquor in the generator to get low and thus raising the level in the absorber, at the same time increasing the amount of cooling water through the absorber to reduce the pressure. Close the valve in the weak liquor supply for a few minutes and pump a vacuum on the absorber, and any liquor in the evaporator will flow into it.

Obstructions sometimes occur in the expansion valves supplying the evaporating coils and also in the pipe supplying weak liquor to the absorber. In cases of this kind the openings should be blown out.

The various details in the case of any plant will depend largely upon its design and construction and must in many cases be learned by experience.

Comparison of Compression and Absorption Systems

Each system naturally has its own advantages depending somewhat upon local conditions. Among those of the absorption system is its simplicity; there are no moving parts except the ammonia pump, which runs at a low speed so that there is but little wear upon it.

In this type of apparatus when properly constructed there is also a steady and uniform operation, and since heavy foundations are not required, the first cost is somewhat less than for a compression plant.

The absorption machine is much the older, but at the present time about 90 per cent of the refrigerating machinery installed is of the compression type.

In making selection of a machine for any given place, the 3 principal points to be considered are practical difficulties in operating, economy in water consumption, economy in steam consumption. In regard to the first, while the absorption machine is the simpler from a mechanical standpoint the cycle of operation is more complex and more likely to get out of balance.

Each stroke of the compressor does a certain amount of work, while, with the absorption machine, changes in steam pressure and temperatures in different parts of the apparatus may, unless carefully watched, disarrange the entire system.

Manufacturers of absorption machinery, however, claim that improvements in recent years have overcome these difficulties to a large extent. It is probably fair to say that either type of machine when properly constructed and operated will give satisfactory results.

Water Consumption

Theoretically, the absorption machine requires for cooling purposes about 2.5 times the water for a compression machine of equal capacity. In either case each pound of ammonia absorbs about 560 B. t. u. when vaporized, and this heat must be taken up by the cooling water at the condenser. In addition to this, the absorption system requires that the weak liquor from the still or generator must be cooled before the expanded gas will be reabsorbed.

The heat of absorption for a pound of ammonia is about 925 B. t. u., which added to 560 makes a total of 1,485, which must be taken up by the cooling water for each pound of ammonia in use in the system. As the amount of cooling water is proportional to the amount of heat to be removed, we have a ratio of 1,485 to 560, or about 2.5 to 1, which shows that an absorption machine uses, theoretically, about 2.5 times as much water as a compression machine of the same capacity.

This difference is reduced in practice in various ways, one of which is the use of the water from the condenser in the absorber for cooling the weak liquor. This, however, will raise the temperature of the absorber water correspondingly. Water may also be economized by using open air condensers or by recooling towers. As this may also be applied to the compression system, comparison on this basis becomes of minor importance and it is claimed by the makers of high grade absorption machines that the economy in water can be regarded as differing in no respect from the water consumption of a compression machine.

The actual quantity of cooling water required by a compression system has been quite accurately established both by computation and by experience, so that in deciding upon a system the actual requirements may be placed before the makers of absorption machines for a comparison with the economy claimed by them for their own outfits.

Table I gives the amount of cooling water per ton of refrigeration, taking into account the initial temperature of the water. These values are based on

a final temperature of 95 deg. F. and atmospheric condensers. In the case of submerged condensers from 20 to 25 per cent more water should be allowed.

Coal Consumption

As the amount of coal burned is dependent upon the steam consumption, we will consider the third item under this head. In the case of a compression plant steam is required for operating the compressor and also for pumps; in an ice making plant power is also required for cutters, crane, etc. It has already been stated that the power required for operating a compressor is from 1.5 to 3 hp. per ton of refrigeration, or roughly, twice that for actual ice making, depending upon the size of the plant. Table II gives the horsepower required for driving the compressor for different sizes of machines.

TABLE I. COOLING WATER REQUIRED PER TON OF REFRIGERATION

INITIAL TEMP. OF COOLING WATER DEG. F.	50	55	60	65	70	75	80	85
GALLONS PER MINUTE	0.625	0.75	0.8750	1	1.2	1.5	2	2.75

These figures are for tons of ice made in 24 hr. and are based on average results as guaranteed by the makers of compression machines.

It will be noticed that the results are somewhat higher than are given by the approximate method noted above.

The quantity of steam required in any given plant and the resulting weight of coal will depend upon the

TABLE II. POWER REQUIRED TO DRIVE COMPRESSOR

HORSE POWER OF COMPRESSOR	10	15	25	43	60	90	120	200	260	350	580
TONS OF ICE IN 24 HOURS	2.5	5	12	20	30	45	60	100	130	180	300

size of plant, the efficiency of boilers and engine, and the care and skill of those in charge.

Table III gives the minimum efficiency of compression plants as guaranteed by different builders. The average of the first 5 plants as given in this table, with capacities ranging from 1 to 100 tons of ice in 24 hr., is 6 tons of ice a ton of coal. In a series of results furnished by over 20 different plants in actual

TABLE III. MINIMUM EFFICIENCY OF COMPRESSION PLANTS

CAPACITY OF PLANT TONS PER 24 HR.	1	10	25	50	100	LARGER PLANTS
TONS OF ICE PER TON OF COAL	4	5	6	7	8	12

operation, ranging in size from 5 to 85 tons of ice in 24 hr., the average results were only 4 tons of ice per ton of coal, the poorest of these being 2.25 and the best 8.22 tons. Taking the average efficiencies of boilers, engines and pumps, consumptions show that considerably better results should be obtained.

Example

A compression plant having a capacity of 12 tons of ice in 24 hr. is equipped with a steam driven compressor requiring 50 lb. of steam a hp. an hr., and the boilers on an average have an efficiency of 8 lb. of steam a pound of coal. The pumps and other auxiliaries require about 20 per cent as much power as the compressor; how many tons of ice may be expected per ton of coal burned?

Looking in Table II we find that a 12-ton plant requires 25 hp. for driving the compressor or a total of $25 + 5 = 30$ hp. for the plant. The weight of steam consumed is therefore $30 \times 50 = 1{,}500$ lb. per hour or 36,000 lb. per 24 hr. The weight of coal required is $36{,}000 \div 8 = 4{,}500$ lb. or 2.25 tons.

The weight of ice produced per ton of coal is therefore $12 \div 2.25 = 5.3$ tons, which corresponds closely with the results given for a 10-ton machine in Table III.

Computations for larger machines with more economical steam consumption will show a greater variation from the results given in the table.

In the case of an absorption machine it is customary to count on a consumption of 50 lb. of steam an hour for each ton capacity of the plant.

Table IV gives tons of ice per ton of coal for a number of absorption machines of different makes, and corresponds to Table III for compression machines.

TABLE IV. TONS OF ICE PER TON OF COAL USED IN ABSORPTION PLANT

CAPACITY OF PLANT IN 24 HOURS	3	8	10	12	15	25
TONS OF ICE PER TON OF COAL	3.8	4.2	5	7	6	4.2

These results are not as uniform as those in Table III, being actual tests instead of averages made up from a large number of tests and arranged uniformly according to size.

AVERAGE COST OF MAKING ICE IN PLANTS OF DIFFERENT SIZES*

By A. T. Criswell

IT IS impossible to estimate, even approximately, on the cost of operating any kind or size of ice plant anywhere without accurate knowledge of the local conditions under which the plant is to be operated. All of the several items that go to make up the cost of operation; labor, fuel, water, oil, waste and incidentals, ammonia, salt, depreciation and repairs, insurance and taxes, and interest on the investment, have different values in different localities.

Labor estimates that would seem very high in small towns would be considered low in large cities. Coal is obtainable in many localities at a cost of $1 to $1.50 a ton, while in others it costs from $3 to $4 a ton and in some foreign countries $10 and upwards.

Water can generally be had for the pumping, but in some instances the cost of this item alone, particularly where no cooling tower is used, may add from 40 to 50 cents a ton to the cost of making ice. Even at the price figured in the table (10 cents for 1,000 gal.) the cost of water will be 50 cents per ton of ice if no effort is made to save it; but it is presumed that no one will be so stupid as to operate an ice making plant without a cooling tower where water must be paid for, and these estimates are based accordingly on using the water over and over for cooling purposes, allowing 20 per cent of the total amount for loss by evaporation —waste and water actually used for making ice—and this is amply sufficient to cover all necessary losses, provided water can be recovered from the cooling tower at a temperature not to exceed 70 to 80 deg. F. In winter the amount of water may sometimes be reduced by 50 per cent or more and in very hot climates the amount required may be doubled.

Oil, waste and engine room supplies will vary only slightly, in cost, for different cities. Anhydrous ammonia costs from 25 to 30 cents a pound in large cities

*Read before the American Society of Refrigerating Engineers.

of the United States, while this cost may be more than doubled in some foreign countries. Salt varies considerably in cost and quality, ranging from $3 to $10 a ton, but it will be seen that this item does not enter largely into the cost of ice; the quantity actually used being comparatively small.

For convenience the interest has been figured at five per cent for 360 days so that it is necessary only to multiply the interest item by 360 and this product by 20 to arrive at the estimated cost of any given plant. Or, as 360 by 20 = 7200, add two ciphers and multiply the interest item by 72. The result will give the estimated cost of the plant in even dollars. For instance, the interest per day on a 5-ton plant is $1. This multiplied by 72 gives $7,200 as the approximate cost of the plant with buildings and site in a small town.

Approximate Cost of Making Ice With Plants of Different Size Operating Under Similar Conditions.

Ice in Tons per Day of 24 Hours.	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	110	120
Engineer, day	210	230	250	270	290	310	330	350	370	390	415	440	465	490	515	540	565
Engineer, night	200	210	220	230	240	250	260	270	280	290	305	320	335	350	365	380	395
Tankman, day	.....	150	160	165	175	180	190	210	210	220	250	(2)380	400	420	440	460	480
Tankman, night	.....	.....	150	160	170	190	190	210	210	220	250	(2)380	400	420	440	460	480
Fireman, day	.....	.....	.....	175	175	190	195	205	210	225	250	250	250	275	300	300	300
Fireman, night	.....	.....	.....	.....	175	190	190	205	210	225	250	250	250	275	300	300	300
Laborer, day	.....	.....	.....	.....	.....	.....	150	150	155	165	175	175	175	175	200	200	200
Laborer, night	.....	.....	.....	.....	.....	.....	.....	.....	155	165	175	175	175	175	200	200	200
Oiler, day	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	150	150	175	195	220	200	200
Oiler, night	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	175	195	220	200	200
Extra Man, day	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	170	200
Extra Man, night	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	200
Fuel, Coal @ $2.50 per ton	250	500	750	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000
Water @ 10c per 1000 gals. (20% of)	50	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
Ammonia @ 25c per pound	25	50	75	100	125	150	175	200	225	250	300	350	400	450	500	550	600
Salt @ $5.00 per ton	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	110	120
Oil, all kinds	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	110	120
Sundries, Waste, etc	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	110	120
Depreciation and Repairs	50	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
Insurance and Taxes	50	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
Interest	100	160	225	300	375	450	525	600	675	750	900	1050	1200	1350	1500	1650	1800
Cost when operating full capacity—Total	950	1630	2325	3060	3800	4410	5110	5720	6435	7050	8400	9730	11040	12240	13500	14740	16080
—Per ton	190	163	155	153	152	147	146	143	143	141	140	139	138	136	135	134	134

NOTE—It is presumed that cooling tower, saving 80 per cent of the water used for cooling purposes, will be used where water must be paid for.

The interest on a 120-ton plant is $18. This multiplied by 72 equals $129,600, approximate cost of the plant in a large city.

I desire to make it perfectly clear that this table is intended to show, approximately, the average cost of making ice in average can plants when operated at normal capacities under the conditions named.

My object in presenting this paper is to call attention to the single item where we may hope for improvement. A study of the table shows that the average cost, per ton, of all labor is about 36 cents; the cost of fuel 50 cents; water 10 cents; ammonia 5 cents; salt 1 cent; oil 1 cent; sundries, waste, etc., 1 cent; depreciation and repairs 10 cents; insurance and taxes 10 cents, and interest on the investment 15 cents. We can hope for very little reduction in the labor account. The other items, with the single exception of fuel, are practically constant and no material reduction can be made in any of them. I believe it is easily within the range of possibilities to reduce the fuel expense by 50 per cent by the use of high class boilers and engines, mechanical stokers, fuel economizers, water purifiers and smoke consumers provided the purchaser is willing to pay the price for a strictly first class plant. Where water conditions are favorable the plate system, or better, a combination of the plate and can system is, in my opinion, advisable; the combination plant being so proportioned that the steam required to operate both systems will furnish the necessary distilled water for the can system and no more. This would add perhaps, one-third to the cost of the installation, thus raising the interest account by five cents per ton, leaving a net gain of 20 cents per ton, or about 15 per cent.

IMPURE ICE AND THE ENGINE ROOM

SOMETIMES ice will show a discoloration in the center of the can, for which the engine room is responsible. Usually the remedy is to see that the feed water is properly purified by the use of a first-class combined heater and purifier and by the use of the blow-off, both surface and bottom, in the boiler itself. The heater and purifier will take out most of the impurities before the water enters the boiler and thus helps not only in making good ice, but prevents the scale from falling on the tubes at the sheet and thus cuts down the amount of fuel needed. The use of such a heater will also tend to reduce the amount of blowing down required in the boiler which economizes both fuel and the pure distilled water. If no heater is employed blowoff should be used every 5 hr. at least.

Arrangement of the surface blow is best made with a pipe having 0.5-in. holes, spaced 5 in. apart in the top of the pipe and the pipe held at 2 in. above the top of the tubes near the front end of the boiler.

In blowing down, the regular blowoff should be opened first and about a half gage of water blown down, after which the surface blowoff should be used to take off floating impurities.

When the discoloration appears in the center of the ice blocks cans should be filled direct from the distilled water tank with water that has not passed through the filter and, if this shows impurities, it means either that the feed water is not properly cared for or that the filter is too small to take out the impurities left in the distilled water. The boiler feed is usually the guilty article and more frequent use of the surface blowoff will cure the difficulty.

If no discoloration is found in the ice frozen from the distilled water tank, then the trouble is in the filter, or in lack of cleanliness in the freezing room. After making certain that all conditions in the freezing room, both of cans and lids, are as they should be, if there is no trouble, the fault must lie in the filter and that will have to be cleaned.

FRICTION OF GAS against walls varies about as the square of the speed at which the gas is flowing. While some motors use a velocity as high as 15,000 ft. a minute, it is better practice to hold this speed down to 9,000 ft. a minute, at which the power loss will be within a reasonable figure.

BRINE STRENGTH AND CAPACITY OF PLANT

By Lewis C. Reynolds

ON PAGE 478 of the August number a reader asks how to calculate the amount of salt required to bring the strength of the brine in an ice tank from 60 to 90 deg. on the salometer. The size of the tank is given as 20 by 14 by 8 ft. deep. In answering the query the quantity of brine in the tank is calculated is 1680 cu. ft., which is the volume of the tank, however as the cans displace their volume of brine allowance must be made accordingly. From data taken on a number of installations it will be found that the ice cans occupy from 40 to 50 per cent of the tank the figure depending somewhat on the capacity of the tank in tons and whether it contains expansion coils or is supplied from a separate cooler. The actual figure on a tank of approximately the size given, with separate brine cooler was 44 per cent. The quantity of salt as recommended in the answer to the query could therefore be reduced about 50 per cent.

In an article on Refrigeration by Chas. L. Hubbard, on the same page as the above query it is stated that careful attention should be given to the strength of the brine as the falling off in the capacity of the machine is often due to this cause. Further on it is recommended that frequent tests be made to keep the brine up to its proper strength. This statement is not correct since by referring to a table on the "Properties of Chloride of Calcium" that the specific heat of brine decreases as the brine is strengthened and that the capacity of a given amount of brine for conveying away heat is reduced. The strength of the solution is governed by the lowest temperature it is liable to reach leaving a sufficient margin between this point and the actual freezing point of the solution to provide for any unusual drop in temperature. Experiments conducted by the writer on a brine circulating system which was equipped with a pressure gage on the pump discharge showed an increase in the discharge pressure of the pump as the brine approached its freezing point due to the formation of an ice coating on the interior of the brine piping. This demonstrates that considerable margin must be allowed between the freezing point of the brine and the temperature of the solution to prevent ice formation on the expansion coils, which would reduce their capacity. There is quite a tendency for the calcium to separate from a strong solution and deposit in the coils, which is another argument against making the solution unnecessarily strong.

ANSWERS TO MASSACHUSETTS EXAMINATION QUESTIONS

PUBLISHED ON PAGE 534 OF THE SEPTEMBER ISSUE

By Pearl E. Merriam

1. The writer considers all indicator diagrams incomplete unless the atmospheric line is drawn, as without knowing the location of this line much must be guessed at.

It is thought that the deformity in the expansion line is caused by the indicator pencil motion or the reducing motion not moving in an unhampered manner. I have had diagrams from engines with riding cutoffs in which the riding valve was not properly squared, causing a re-admission of steam at one end of the cylinder similar to that shown. I have also had cards from the high-pressure cylinders of compound engines, equipped with small receivers and the low-pressure cutoff adjusted by hand similar to that shown, by the formation of a loop at the end of expansion.

The explanation is this: The cutoff was short on the low-pressure, a heavier load came on the engine and the receiver pressure went up as more steam was discharged into it from the high than the low-pressure cylinder was taking out.

Under this condition, the high-pressure exhausts below its back pressure (receiver pressure) forming the loop on the end of the expansion line.

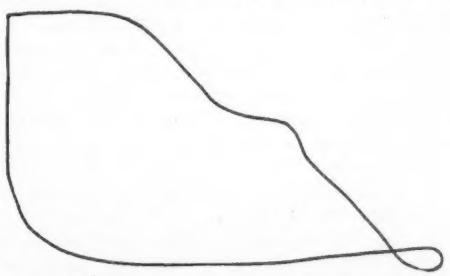
2. Steam valve leaks after cutoff, the expansion line is higher than it should be for that cutoff the terminal pressure is higher. The exhaust valve leaking reduces the compression pressure and with some leaky valves a peak is produced as at 1, Fig. 1.

3. Should the valves on the high-pressure cylinder leak, the low-pressure cylinder would do a greater proportion of the total work as the receiver pressure would be higher than obtained with tight valves.

4. If the receiver pressure is higher than necessary to balance the load, that is, to have each cylinder do an equal amount of work, the high-pressure may expand below its back-pressure line as above stated and indicating a wasteful condition, also the low-pressure cylinder would carry a heavier load than the high when the receiver pressure is raised above that necessary to balance the load.

5. To equalize the load between the cylinders of a compound engine, adjust the low-pressure cutoff as required.

6. Slight changes of speed of a Corliss engine may be made by moving or hanging weight on the arm or



READMISSION AND HIGH BACK PRESSURE

arms provided for that purpose on the governor. If any changes above 4 or 5 r. p. m. are required, either the pulley which drives the bevel gears driving the governor or the pulley on the crank shaft should be changed.

If it is decided to change one of the pulleys, it should be done with a view to maintaining the speed of the governor, the same after the new speed of the engine has been obtained as before any change of speed was made.

7. As most high-speed engines are fitted with a

single valve, if the steam edges are scored and leak, the steam line will appear high; if the exhaust edges leak, the compression will be reduced as shown by the dotted lines, Fig. 2.

8. Since both engines are doing the same work, the horsepowers are the same. In the majority of cases, the automatic engine is the more economical.

9. The direct acting steam pump carries steam full stroke when not provided with a crank and flywheel because the main steam valve cannot be rigidly connected to the piston rod. If it were rigidly connected, in place of being operated by auxiliaries, the

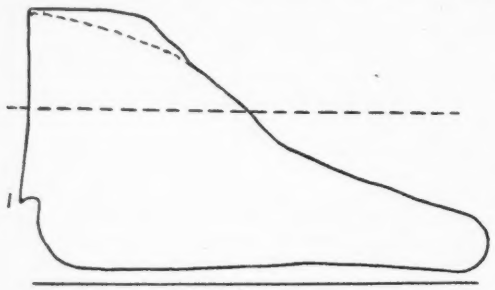


FIG. 1

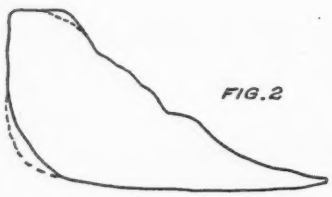


FIG. 2

FIG. 1. INDICATOR CORD SHOWING LEAKING STEAM AND EXHAUST VALVES

FIG. 2. CARD FROM HIGH-SPEED ENGINE SHOWING LEAKING VALVE

main steam valve would cover the steam port before the stroke of the piston was completed and the pump would stop.

The only pumps having a cutoff are of the crank and flywheel type which are of greater capacity than the pumps ordinarily termed direct acting.

10. The diagram from an intermediate cylinder would not differ materially from the diagram from the other cylinders. And as for the leaky appearance of such a diagram, the diagram of Fig. 1 can be considered as coming from the intermediate with leaky valves, the only difference being the falling off of the steam line as shown dotted, also the elevated position of the atmosphere line.

11. If the leak was sufficient to reduce the mean effective pressure of that cylinder, the second receiver pressure would be higher than usual and, with the same adjustment of low-pressure cutoff, the low-pressure cylinder would do more work.

12. The engine will be wasteful as a whole, if the leak amounts to much, because a greater volume of steam is necessary to develop a given power than with a tight engine. It must be borne in mind that most engines that have been in use many years leak more or less. If the exhaust valve leaks, the results as noted above may be encountered, the m. e. p. will be reduced.

13. The governor changes the point of cutoff on a Corliss engine by moving the knock off cams through the reach rods which connect the cams and the governor. When the governor rises from any cause, the cams are rotated in such direction as to cause them to engage the steam valve hook earlier in the stroke of the piston thereby reducing the volume of steam admitted for that stroke. When the governor drops to a lower position for any reason, the opposite action takes place.

14. In engines with releasing gear, the action of determining the cutoff is as above outlined. For engines with a positive valve gear, the eccentric is advanced or swung backward on the shaft by the shaft governor, thereby moving the steam valve direct, giving it a greater or less travel, or advance, as the load requires.

15. In most cases it will be found necessary to increase the compression on an engine when changing from noncondensing to condensing. This is because a greater volume of steam must be retained to give an easy and quiet rotation at the lower pressure. If the load is such that the cutoff takes place fairly early, more lap may be placed on the steam valves and the eccentric advanced on the crank shaft, causing both an early opening and closing of the exhaust valves which is desirable within reason.

If the load is such that the advancement of the eccentric as stated would reduce the range of cutoff to a considerable extent more lap may be given the exhaust valves by lengthening the radial rods from the wrist plate to the exhaust valve cranks. This will make the exhaust late and give more compression.

16. If the cutoff in the high-pressure cylinder is late, due to the engine carrying a greater load than designed to carry, the engine will be wasteful because the machine is not proportioned to develop the total power required. Part of the explanation of the diagram, Fig. 1 on p. 534 of the September issue, as given here, applies to this question. Again, the receiver pressure would rise unless the low-pressure cutoff was lengthened when the high-pressure cutoff came late, the relief valves on the receiver and low-pressure cylinder would open provided they were set slightly above the pressure to divide the load between the cylinders, and thereby reduce the reveiver pressure until the conditions could be changed.

HAND VS. STOKER FIRING

As an illustration of what regular firing as handled by a stoker will do compared to hand firing the results of a comparative test made at the 40th St. Plant of the Chicago Railways Co. are important.

The boiler was a 100-hp. return tubular with Illinois slack coal. Hand firing was used for 8 hr. on April 21 and stoker firing for the same length of time on May 27.

Comparative values for the 2 tests are as follows:

Firing—	Hand.	Stoker.
Steam Gauge (lb.)	58.7	65.
Feed Temp. (deg. F.)	48.	52.
Uptake Temp. (deg. F.)	450.	400.
Total Coal (lb.)	4800.	4800.
Total Refuse (lb.)	462.	431.
Refuse (per cent)	9.6	8.98
Factor of Evaporation	1.20	1.198
Actual Evaporation per lb. Coal	5.025	6.635
Evap. from and at 212 deg. per lb. Coal	6.03	7.949
H. P. Developed	104.9	138.2
Efficiency Boiler and Furnace (per cent)	55.5	73.5

"MAN MOVES in a mysterious way his blunders to perform."

DISABLING A POWER PLANT, AND THE RESULT

A SHORT TIME ago the little town of Glasgow, Mo., where the Chicago & Alton steel railroad bridge crosses the Missouri River, was the scene of great excitement. Ordinarily it is a sleepy hamlet with nothing to disturb its slumbrous tendency. But here, of a sudden, it finds itself on the line of the New York to Seattle automobile race and the background for a drama of trickery and daring.

Besides the railroad bridge, the means for crossing the river is an antediluvian ferry, wheezy engines, creaky, racking boat, deliberate engineer-ferryman, doing deliberate trips across the muddy waters and with extra-deliberate waits on the muddy banks between trips.

Into this quiet comes whirring down to the ferry the first of the cars in the race. No time to lose now, for others are not many miles behind. Urging makes but little change in the speed of action of his majesty of the ferry; he has his regular trips—and impatience suggests a hunt for other means of crossing. But to the seeking of the racers there is no reply but "Yer take the ferry, or yer swim, or yer ride in ther keers."

By the power of the almighty dollar it is finally found possible to set forward the time of the next trip by some hours and the auto is rolled aboard, with some misgivings as to whether it will next touch land on the other side of the river or at the bottom.

The ferry engines groan and chug and the boat creeps out into the stream.

Now comes Satan on the scene with wily temptation and between the driver of the gasoline land wagon and the driver of the steam water wagon passes the following:

He of the water—"I spose ye have a right smart o' trouble with yer machine and yer gaserline engin', don't ye?"

He of the land—"Oh, not much. Gets a little hot sometimes an' sometimes dirty, but we've had good luck most of the way."

The Waterman—"Gee—I always tho't them gas enjins wus terrers ter git outen order, and my steam shebang gives me all the bother I want."

The Landsman—"Does she break down often?"

The Steam Driver—"No, not to say often; but occasionally. Mebbe once a week; mebbe twice. Depends on how she feels."

The Autoist—"Isn't she about due to break down now?"

The Boatist—"Wal, she broke last time of a Tuesday and this's a Friday. Kaint tell. She mought."

He of the Chug Wagon—" 'Twouldn't be strange if she broke down on the trip back after hurrying her on this trip, would it?"

He of the Chug Boat—"No."

The Gasoline burner—"Might take a day or two to fix 'er up?"

The Coal burner—"Might ef she wuz to be fixed up right."

Then coin of the realm passed sufficient to pay the ferriage and several days' earnings of the ferry, and the auto trundled ashore on the west bank and disappeared in a red haze of dust while the chaffeur chuckled at the start he would get over his pursuers.

On the return trip of the ferry mysterious hot boxes at crosshead and crankpin which scored the brasses, and the sudden disappearance of an important set screw in the valve gear just as she made the dock tied the boat up for repairs, which the engineer seemed in no mood to hasten.

His friends urged, "There'll be other autos here soon and you won't be ready."

But he said with determination, "She's goin' ter be fixed right so she won't play me no sich trick again." And he hammered and filed and scraped as if he was a government pensioner.

Then from afar comes a hurrying "Honk-Honk" and with a swirl and a jump the driver is aboard the old boat.

"How quick can she get across, and how much for your quickest trip?" said he, all on edge to cut down some of the lead of the machine ahead.

"She's—busted," was the slow and sure answer.

"Well, how long to fix her and can't she run somehow? Money's no object."

And the boatman had to answer "Nope. Kaint run 'er 'til termorrer," for he had "fixed" her even better than he meant to.

Here imagine a season of grim despair on the part of the autoists, inquiries as to other methods of crossing. Time to reach up and down to the next ferry and the possibility of getting a flat car on the railroad. And then— An inspiration!

"Climb in," said the driver grimly to his wondering companion, and the loungers on the river bank guessed lazily at "what ailed him now."

Up they whirl to the Chicago and Alton station, to a crossing and turn in on the right-of-way, headed for the bridge. Full speed a-head is now the word. It's no time to stop to ask questions or permission. The west shore's the thing to gain, and at 40 miles an hour one doesn't feel the ties much anyway.

So the astonished ferryman sees above his head the auto shoot by and across to the west in a quarter the time his ferry could have made and with no payment to anyone; and for 2 miles further finding the roadbed good the auto sped along the tracks. And the next day 2 more autos, hearing the story, took to the tracks and left the ferry, and the next day 2 more until it was a losing game for the ferry engineer besides the work of fixing up the bearings.

As on any well managed road, the officials of the Alton got greatly excited and got a deputy marshal's appointment for the Glasgow ticket agent and sent word to the section foreman to catch and hold any auto trying to cross the bridge; so the autos went back to the boat and slumbrous quiet fell once more on Glasgow and its ferry.

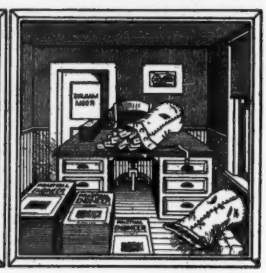
But the Alton traffic department looked on it largely as a joke and one more proof that for anyone wanting to go from east to west in the shortest time and by the quickest route, the Chicago and Alton is "the only way."

ONE OF THE LATEST VICTORIES of power over space is the record made by the Lusitania, which made the trip from Queenstown to Sandy Hook in 4 days 11 hr. 42 min., thus cutting over 3 hr. from the best previous record and landing its passengers in the fourth day out from Queenstown.

ON PULLEYS LESS THAN 12 in. diameter it is best to use single belts; between 12 and 20 in. diameter double belts and between 20 and 30 in. triple belts.

Letters From Engineers

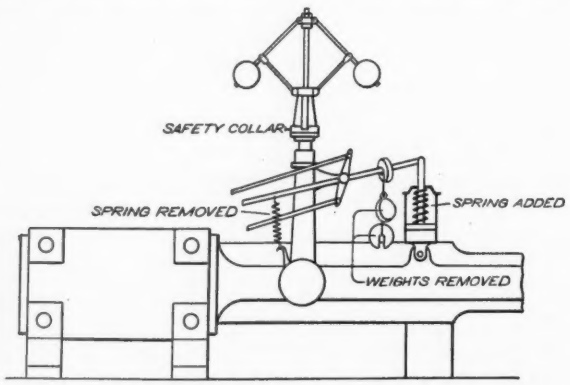
Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.



An Exciting Race and How It Was Won

I was at one time called upon to take charge of a small plant which consisted of 2 Babcock & Wilcox boilers, and a 12 by 30 in. Watts & Campbell engine, with an old style crab claw releasing gear. It was Monday morning when I appeared on the job, and after I had looked the situation over carefully the foreman told me that the engine raced, which was not surprising to me considering the way it was decorated with weights and springs. I oiled up, however, and got ready to start, then told the fireman to blow the whistle, and we were ready for work.

I watched the load come on, and as it did, the governor would drop and taking full steam would race, then it would jump up to the top and slack up the speed, its next move being to work down slowly and



CORLISS GOVERNOR WITH ADORNMENTS

start to race again. I decided to take some of the weights off, and by experiment see if I could not secure better regulation.

The first move was to pour some kerosene through the top of the governor and loosen up some of the gum that was there, and then take off the weights. The results obtained by this change were no better, however, so I unhooked the spring, and the governor ran up, thus slowing down the engine. After putting the spring back I left it until noon time when I had a chance to look at the dash pot.

When the dash pot was examined I found it filled with thick molasses, so took out the plunger, when I found all the holes but 2 plugged with screws and wooden plugs. The 4 wooden plugs were taken out and the dash pot filled with cylinder oil, after which the weight on the lever was regulated, and I started up. Fair regulation was secured by these means, but it did not stop the racing.

We ran along, however, better than before, the governor controlled better, but as the load was so irregular, the engine would race when the load was lightened. I thought it was due to the elevators as there were 7 of these, and some carried heavy loads of freight. These elevators were all run by belt, so I watched the engine for 2 or 3 days, and concluded that a spring on the plunger rod of the dash pot would do the work, so I secured a compression spring about 4.5 in. long and 0.75 in. diameter, put it on the rod, and used the cover to regulate the tension by screwing it up or down.

The spring at the other end of the governor rod was then taken off and the weight brought over to the opposite end and regulated until I had the proper speed, when I loosened up the jam nut on the cam rods, and regulated the cams to have an even cutoff. No difficulty with the racing of the engine has since been experienced, and by using kerosene on the governor about twice a week we get good regulation.

The accompanying sketch shows how the governor was weighted and the location of the spring which was removed and also indicates the position of the spring in the dash pot.—E. H. S.

Boiler Topics

There was an interesting case of unequal boiler draft given by a correspondent which I have not seen discussed. I would suggest that, even if the connections from flues to smokestack were all right, the draft might still be unequal, if the air could not enter each ashpit with equal freedom.

If the boilers were situated along a narrow passageway with only a small doorway at one end, the effect would be exactly as he describes, but I would hardly think that it would be so noticeable as he states under practice conditions.

The suggestion expressed by a correspondent that chlorine and hydrogen would unite explosively in a boiler would hardly seem to be probable. It is generally stated in chemical text-books that chlorine and hydrogen will not combine except in the presence of light, which is certainly not existent in the interior of a boiler. It must also be considered that the product, hydrochloric acid gas, is very soluble in water.

The compressed air oil-lift described in the May issue seems to me to be unduly complicated. Why not fix up the reserve tank by the side of the supply tank and connect the two?

The suggestion in a recent issue that a pump suction be tested with an aneroid barometer hardly seems practical. In the regular vacuum gage, the outside of the flexible tube is exposed to atmospheric pressure, and the inside to partial vacuum pressure, but in the aneroid barometer matters are just reversed. Consequently to use the aneroid barometer an airtight box would have to be constructed, its interior connected to suction, and the barometer placed inside. But there would also have to be a glass window in the box in order that the position of the pointer might be seen.

C. L. F.

Diagrams From an Ammonia Compressor

The accompanying diagrams were taken some time ago from a pair of single-acting ammonia compressors 9.5 by 12 in. The diagram from the left hand compressor does not look very bad but the diagram from the right-hand compressor shows that cylinder to be doing very little work. This was evident before the diagrams

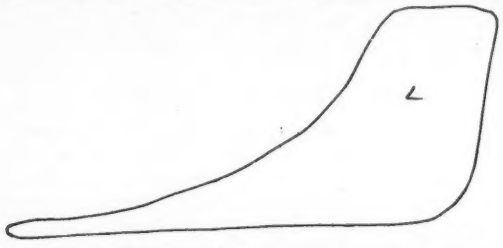


FIG. 1. LEFT HAND COMPRESSOR CYLINDER CARD

were taken by the amount of cooling water required to keep the cylinders cool, the left-hand cylinder taking about twice as much water as the right side.

The diagrams were taken with a 120-lb. spring; the back pressure was 30 lb. gage, discharge pressure

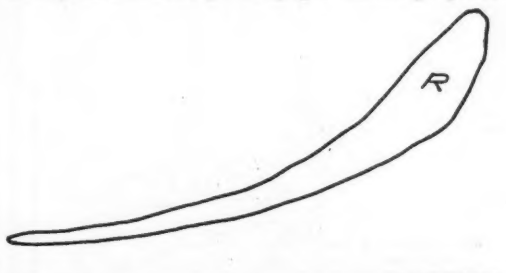


FIG. 2. CARD FROM RIGHT HAND COMPRESSOR CYLINDER

210 lb.; speed 80 r. p. m. Diagram 3 was taken from the steam end of the same machine cylinder 13.5 by 12 in., with Corliss valve gear. The valve stems were so badly worn in the bonnets that it was impossible to get them to open as soon as they should. At the time the

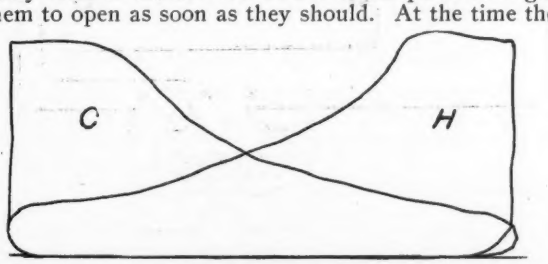


FIG. 3. DIAGRAMS FROM STEAM END OF COMPRESSOR

diagrams were taken the machine was making 7.5 tons of ice and 1.5 tons cold-storage per 24 hrs. Any criticisms on these diagrams will be appreciated by the writer. J. C. H.

Connecting Rod Bolts

In the September issue of Practical Engineer a friend is complaining about breaking bolts in stub ends of connecting rods. The cause for the breaking is evidently due to several causes, 2 of which might be faulty machine-headed bolts, which may be due to overheating or underheating; either of these faults would produce a weak bolt. They may be tightened up too hard and all the tension, almost to the breaking strain, taken up, which is with a bolt of this class considerably less than the strength of a first-class hand-made bolt. If made of good wrought iron they would possibly stand more jar than most of the steel, so called, if a little overheated. A good hand-made bolt of either steel or iron with a 3/16-in. hole drilled through it lengthwise from head to point for a ¾-in. bolt will be found to add considerable strength to a bolt exposed to heavy jars. But it should never be set too tight. If it will not stay set the thread should be long enough for a jam nut, which will hold better than the head of the bolt on the strap or butt end of the rod. J. K. B.

Steam Gage Connection

Figure 1 shows how one of our steam gages was connected to the water column in order to bring it down lower. One Monday morning after firing perhaps an hour it was noticed that the steam was raising much slower than usually. I was sure there was plenty of water in the boiler and everything was as it should be. Being near starting time, the fire was forced more to get the steam pressure up to the right point when shortly after the safety valve started to blow, steam pressure on steam gage showing about 65 lb. while the safety valve is set to blow at 110 lb., showing that there was something wrong with the steam gage.

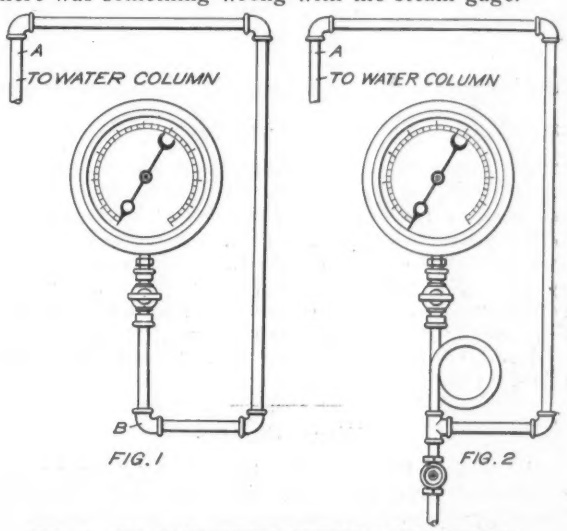


FIG. 1—OLD GAGE PIPING WHICH GAVE TROUBLE
FIG. 2—PRESENT SATISFACTORY ARRANGEMENT

Upon examining it was found that the short nipple A was nearly clogged up with scale from the pipe, not allowing full boiler pressure to the steam gage; when this nipple was cleaned the gage showed the right pressure.

The piping was changed to that showing in Fig. 2 by placing a circle and a tee at the bottom of the steam gage in place of the ell, B; to this is attached a short nipple and valve. The pipe was blown out a few times during the week and there has been no further trouble with the pipe clogging up from scale.—H. J.

An Accident to a Cross Compound Condensing Engine

In an engine room in a neighboring plant there was recently a great smash up and a particular friend of mine who is in charge there, can thank his stars that he is alive to tell the tale.

As usual the engine was started a few minutes before 6:30 a. m. and everything was in good order as was always the case; it ran along for about 12 min. with full load of about 1,000 hp. when the engineer noticed that he was losing his vacuum and going

to the condenser to turn on more water, he was hardly through the door of the engine room when the low-pressure side let go like a cannon.

When the steam was shut off it was very evident that it did have some force behind it for a piece of the steam chest 28 by 32 in. and all the valve gear on the steam side of the low pressure side was blown away. The steam chest was blown away in pieces, and the bracket that supports the valve gear was blown with such force against the high-pressure side that it broke the steam chest on the high-pressure side and also the valve steam, putting both sides out of the running. The reach rod was bent to a quarter turn and was swung around in front of the flywheel with the rocker and all the valve rods where they broke off from the valves.

This engine was a 22 3/32 by 44 by 48-in., running 90 r. p. m., at a steam pressure of 160 lb. boiler gage

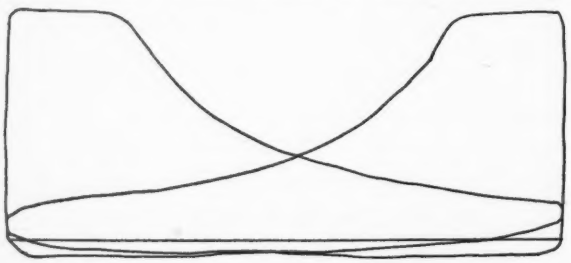


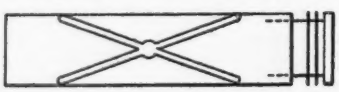
DIAGRAM FROM HIGH-PRESSURE SIDE OF WRECKED ENGINE

and, as there was a valve about 50 ft. away from the engine room, the engineer had a chance to shut it without shutting down the other units that were running in the plant. The plant was very busy and had to have power, so the high-pressure side was repaired by putting a patch on the broken steam chest and getting new valve stems for those that were broken. The low-pressure cylinder is only good for scrap.

Enclosed is a card taken from the high-pressure side as it is. M. J. C.

Warm Guides

A friend of mine recently took charge of an engine which had been giving trouble with warm guides. The slipper seemed to scrape the oil away instead of sliding over it, so he took the first opportunity to investigate. The guides were V shaped, and instead of



BABBITT SLIPPER FOR GUIDE

babbitt metal being poured into the crosshead shoes, 2 babitt slabs about ⅜ in. thick were slipped under the shoes, one for each side of the V. These were retained in place by flanges on the side and a plate on each end bolted to the crosshead. As soon as one of these plates was removed the trouble was apparent. The babbitt slabs had been made about ⅛ in. short and this had been remedied by adding several thin shims. These had originally been placed so that they would not touch the guides, but in course of time had dropped out of place and were scraping the oil.

The 2 babbitt slippers were taken out and a liner made to fit each, of ⅛ in. brass. Holes 2 in. apart were drilled through liners and into the end of the slippers. Then pins were riveted into the liners. This gave him shims that would not fall down and if at any time there should be any lost motion, the ⅛-in. brass shim could be slipped out and a thin one added by fitting over the pins and the whole thing replaced. The engine has given no trouble through warm guides since the repair was made. The slippers had been nicely rounded off at the ends so that they would not scrape the oil, but this precaution had been rendered of no value by the dropping of the shims. The accompanying sketch shows one of the babbitt slippers, the brass shim with pins, and 2 thin shims added. W. E. D.

Starting Rheostat Connections

On page 485 of the August issue of Practical Engineer, the question, "How shall I connect up a shunt motor, etc.?" is answered by means of a diagram, which I herewith reproduce, Fig. 1, in order to point the error which it contains. Doubtless it was a mere oversight on the part of the person drawing the diagram; and while there is little chance of trouble resulting, due to the fact that, generally, starting boxes leave the factory with their interior connections correctly made, the point to be considered is this: If a person is not well versed in practical electrical work,

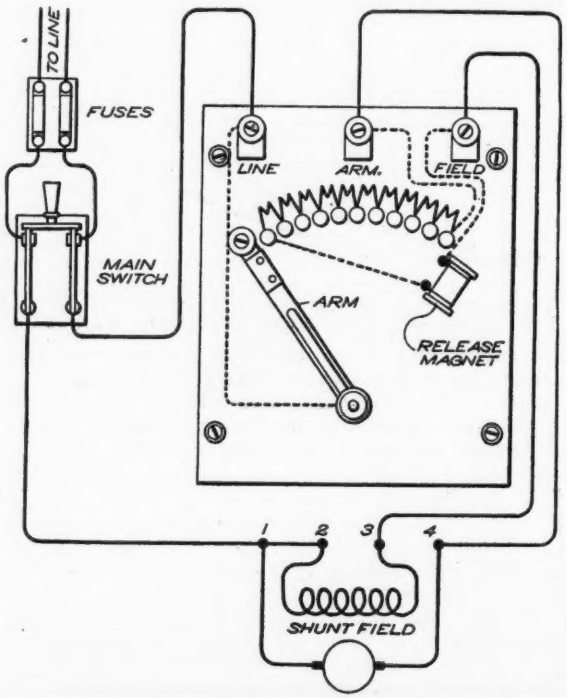


FIG. 1—IMPROPER STARTING RHEOSTAT CONNECTION

and we are led to infer such to be the case here, judging from the elementary nature of the question, he will begin to tinker, blindly, at the first sign of trouble with his motor.

After removing a few connections he is at a loss where they belong; and should he refer to the diagram in making the interior connections of the rheostat, he is liable to see sparks. A good electrician doesn't hunt inside the starting box for trouble—it is the fellow who doesn't know much about the subject, although troubles may be traced to the starting box, but it is done knowingly then.

It will be interesting to consider what would probably happen should a rheostat be so connected up. The first thing to be noticed is that there is no provision made to have a full field on the motor before

starting, and this is essential for shunt motors. Further study of the diagram will show that with the arm of the rheostat on the first contact point we obtain full field current and at the same time a small current will flow through the armature.

At the instant of starting, however, the armature current is likely to prove large, as it takes the field an appreciable time to build up. On moving the arm farther to the right we cut out armature resistance but at the same time the field is being decreased because the field current has to flow through the armature resistance to reach the field coils; and by the time the arm is on the last contact point the field will be so weak that the speed will be excessive, if the fuses are

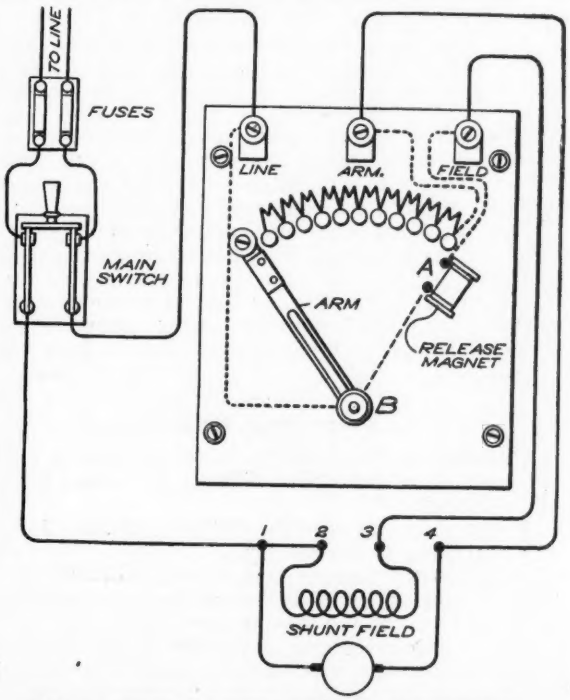


FIG. 2—RHEOSTAT WITH CORRECT CONNECTIONS

not already blown by large starting current, which is also affected by a weak field. The release magnet will probably refuse to hold the arm against the tension of the spring.

If the speed and current are not great enough to blow up the armature, the chances are that if the operator is not of a mechanical turn of mind, he will lash the arm to the release magnet and proceed with his wood sawing or fodder cutting only to find that, although the "pesky" thing went around like tarnation, it will die down when work is put before it.

If the connection which is made between the magnet and the first contact point be changed to points A and B, Fig. 2, the trouble will not occur if the diagram is used for reference. Joseph Jacobs.

How Much Compression?

In looking over the October number of Practical Engineer I saw some answers to Mr. Freeman's query on compound engine diagrams published in the August number that should not be let pass, as it might give some engineers a wrong idea. In the article by E. V. R. he states that the eccentric should not be set ahead because the cards could not be improved upon if a quiet, cool running, economical engine is wanted.

Now, if Mr. Freeman would tell us the facts, I think he would say it was a tough proposition to keep his engine from pounding, as there is no compression and lost motion will be taken up suddenly at the end of every stroke, and the engine will not run quiet no matter how close the boxes are adjusted; the only remedy is to have the exhaust valves close earlier for compression.

As regards a cool running engine, if E. V. R. had an engine with pins too small and the load on the engine was such that the pins ran quite warm, and he had compression up to 0.5 boiler pressure, if he changed the setting of exhaust valves so as to get practically no compression, the pins would run so hot he could not run the engine. I know this to be a fact as I have seen it tried and in less than half an hour the engine had to be stopped as the crank-pin was on the point of smoking, and the wrist-pin was very warm.

The pins got hot because the lost motion was taken up suddenly at the end of every stroke causing a hammering of the boxes against the pins. This is on the same principle as a pin getting hot by having too much lost motion in the boxes.

After the pins had cooled down and the exhaust valve setting was changed back again, the pins ran no hotter than usual. The reason for this was that the lost motion was taken up gradually without the hammering tendency.

E. V. R. says that compression is a loss of power, and it is as far as the capacity of the engine is concerned, but it is not always a loss in ecenomy. If an engine is cutting off late in the stroke and it is not practical to raise steam pressure, it will be found economical to give as little compression as possible and still have the engine run quiet, as then cutoff will be earlier and steam will be expanded to a lower pressure.

But with conditions met in ordinary practice, it will be better economy to give compression, sometimes up to boiler pressure.

He also says "exhaust valves should open earlier, but then lead and compression would be changed." If he understands the principle of a Corliss engine he surely must know that release can be changed without changing the other events. If the exhaust rods leading from the wrist-plate to valve cranks are changed in length to correspond to 0.5 the amount the valve is to be opened earlier, then compression will be as much later as release was made earlier; but release has been changed only 0.5, the desired amount; so, if eccentric is advanced a little to get the other 0.5 required, compression will be brought back to where it was before any change was made. Lead can be reduced to the original amount by changing the length of steam rods.

To my thinking, the cards shown are very bad, and if Mr. Freeman will advance the eccentric for earlier release and compression, the exhaust rods will have to be changed very little if any; then change length of steam rods so that admission line will be perpendicular to the atmospheric line; the steam line will hold up and there will be a noticeable saving in coal, and he will have a quiet, cool running, economical engine.

I think compression from 0.33 to 0.5 boiler pressure will be about right in his case. The above suggestions hold good for both high and low-pressure cylinders. H. W. C.

TO EVERY BARREL OF LIME estimate about 5/8-yd. of good sand for plastering and brickwork.

Pump Troubles and the Remedy

In our plant we have a small pump used for pumping water from a driven well and as it had not been working properly, we thought that repacking the piston on the water end would help matters. After taking the outer nut on the piston rod off, we discovered that the inner one was so rounded that the socket wrench was useless, so a wrench similar to that shown in Fig. 1 was made, which would go over the nut and

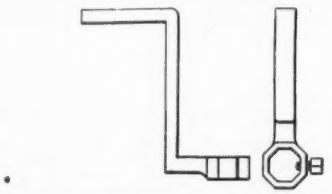


FIG. 1—A HANDY SOCKET WRENCH

by putting a washer between it and the outer nut which was put on a couple of threads, held the wrench so that it could not slip and we were then able to take off the nut without much trouble, as the set screw could be made to hold the nut tight in the wrench.

After repacking and getting the pump together again, it would not pump much water and this only at intervals. This was a puzzle for a while as we had

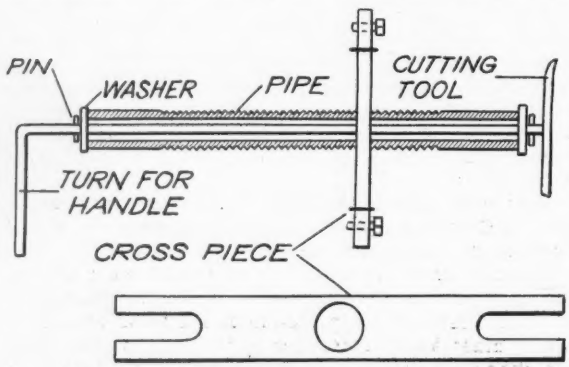


FIG. 2—TOOL USED IN BORING CYLINDER

no vacuum gage, so that the steam gage was altered by changing the lever, and tensor so that it would record the other way. When this was attached to the suction pipe, it did not register more than 20 or 30 in. which would bring the water up no more than 18 to 19 ft., and the water was 23 ft. below the piston at that time.

After thinking the matter out we came to the conclusion that there was too much clearance between the plunger ends and cylinder heads as the pump never worked properly after the stroke was shortened, which was sometime before. Putting in a short supply of packing with thick gaskets on the end made matters still worse, as the cylinder had become worn on the end from running at a short stroke. It was found necessary to rebore them, which was done with the tool shown in Fig. 2.

After calipering the most worn part it was found to be so near the size of one of the reseating machine cutters that we used this, putting the cutter on the end of a threaded rod, which was adjusted inside of a piece of pipe that was threaded the length of the cylinder, and held in by a pin with a washer on each end.

The pipe which was to regulate the feed was screwed into a piece of flat stock, cut out on each end so that it could be centered easily, and held in place by the cylinder head bolts. After boring the cylinder, repacking the piston, and giving the pump its full stroke, the vacuum gage showed 24 in. and we could not ask for a better working pump.—D. F. Crowther.

Banking Fires

I see on page 608 of the October issue of the Practical Engineer, that I would have to fire my prettiest or get a call down; now what does H. A. mean by a call down? Does he mean that I would be given a calling down by the superintendent or manager? If so I am glad to say that is something I have to get yet by using the method I gave on banking fires.

And I have used the method for 8 yr. where I had a load up to shutting down time. This was in a flour mill, and any one used to mill work knows that the load is on until time to stop.

This method can be used in any plant, but care must be used in banking fires by using any method, and we all know that the same method can not be used in all plants, with different grades of coal.

Now I do not want the readers to think that I meant for you all to use the method I gave in banking your fires, for you may get into trouble; although I have kept out of trouble for 8 yr. and the engineer that took my place has used the same method and so far he has not got a calling down! That has been 7 yr.

L. A. Cole.

Boiler Room Rules

Our chief engineer had the following rules printed and hung up in the boiler room of the power house where I work.

Firemen coming on duty shall in presence of man they are going to relieve, try all try cocks, blow off all glasses of water gages, give all water columns thorough blowing off on all boilers under steam, examine all blowoff valves and see they are closed tight.

On finding everything in proper condition report to the engineer in charge of floor to that effect or call his attention to anything that you may find wrong and inform him you are ready for duty.

Firemen coming on at 2 p. m. shall pop each safety valve by hand.

Firemen coming on at 10 p. m. shall blow all water fronts or arches at time when fires are banked and when steam pressure is lowest and also blow all tubes while plant is shut down.

Firemen coming on at 6 a. m. shall open blowoff valve on each boiler under steam, that is one at a time leaving blowoff valve open at least 20 sec., being careful to open and close valve slowly.

On going off duty, firemen shall leave the boiler room in a neat condition, that is floor swept, oil cups filled on pumps, or in other words every thing in first class condition for the next shift.

No boiler shall have fire started under it without first trying gage cocks. Don't rely on glass water gage. If you can't get water at gage cock, don't fire it! And boiler shall contain no less than 1.5 gages of water. Leave safety valve open until steam blows freely. Maintain as even running steam pressure as possible, maintain even water level, 2 to 2.5 gages; try cocks to be tried at least once in 30 min. Don't rely on glass gage. Always notice that water is moving in gage glasses. Firemen will report any leak which they discover, while on watch.

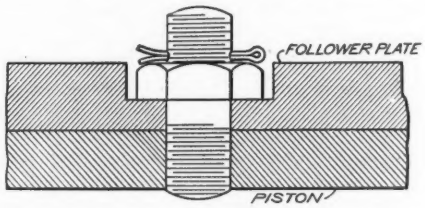
In case of sickness or being unable to report for

work, a notice of at least 3 hr. must be given and 10 hr. if possible.

These rules were very effective in keeping down friction among the firemen. I thought they would be interesting to the readers of your most valuable paper. Thomas Sheehan.

Method of Securing the Follower Ring

In recent issue of Practical Engineer I read the description of an accident which O. L. Harper had with his Corliss engine piston and follower plate. Judging from his description, I think if he would do away with the cap screw, and put a stud in its place



STUD BOLT WITH COTTER PIN FOR PISTON

with a cotter pin in the end of the stud above the nut, he would have no more trouble of this sort.

The cause of the breakdown, I should judge, was that one of the bolts came loose and working itself up struck the head of the cylinder upon one stroke and bent over, thus prying the follower loose and when the piston came back on the next stroke it broke through the cylinder head, and part of the follower plate went into the exhaust port. The accompanying sketch shows the arrangement which I would suggest. R. J. F.

Boiler Pump Troubles

Referring to the article on page 607 of the October issue, I will say that placing an air chamber between the check valve and the main stopped the hammering at the hydrant, and I thank the engineers for the suggestions.

I have a 5.5 by 3.5 by 5 in. duplex boiler feed pump, pumping against 125 lb. pressure. I have also 2 water systems, one with 8 lb. pressure, and the other with 45 lb. My pump began to lag, and would not supply the boiler from the low pressure tank, and with difficulty from the high pressure , so I opened up the valve chest and found that the check valves were allright. I then examined the feed valves and found them working properly. My next step was to take off the steam head, and upon doing this I found a small portion of the packing on the rib between the cylinders had blown out. After putting in a new gasket the pump worked as nicely as ever.—J. H. J.

An Old But Good Corliss

I am showing 2 cards, also an idea of the valve gear, which I once had charge of, which shows pretty fair steam distribution for one that has been in constant service in its present location 43 yr. and 10 yr. in another place, making it over 53 yr. in service, and by no means worn out yet.

It was built by the Corliss & Nightingale Co., which, as is known, as the original inventors, and bears the patent date of 1851. It is a 16 by 48-in. Corliss and a look at Fig. 1 of the valve gear shows that wooden knock off stick which is shown in position, preventing the valves from picking up. The wear of this stick will give a card like Fig. 2 the right side showing the most work because the stick wearing short met the knockoff later, hence a longer cutoff. This is evened up by putting liners under the plate A to keep the sticks the original length.

For over 30 yr. this engine has had a sideways play at the cylinder head and which is now ⅛ in. and

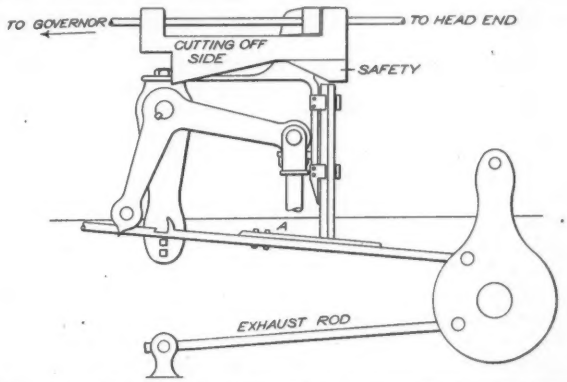
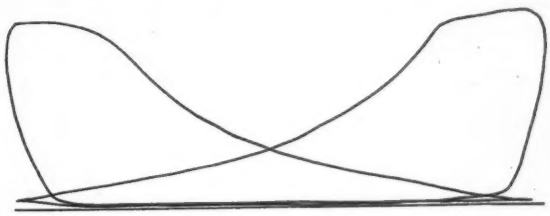


FIG. 1. CORLISS KNOCKOFF GEAR ON 53-YR.-OLD ENGINE

from good authority it used to move 3/16 in., due to the springing of the whaleback.

Until a year ago this engine never had any safety arrangement and many is the time the hook rod has unhooked itself because of running away. I have



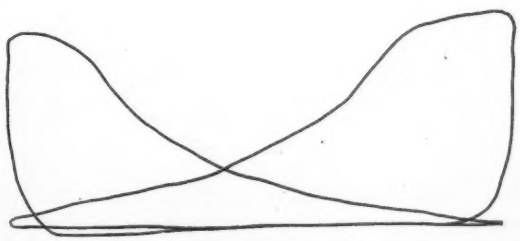


FIG. 2. DIAGRAM WHEN CUTOFF STICK IS WORN, THEREFORE SHORT

FIG. 3. DIAGRAM AS NOW RUNNING IN GOOD CONDITION

known an ordinary grease cup 2 in. diameter, 2.5 in. deep to run on the crank pin 9 months with only 1 filling, and never saw the pin beyond the temperature of the room. A. C. Waldron.

WIRELESS MESSAGES from the Glace Bay station in Canada have frequently been picked up by the Eiffel Tower receiving station in Paris, so that transatlantic wireless communication is an accomplished fact.

WHILE WAITING for an opportunity to come along so that you can improve it, what's the matter with improving yourself to be ready for the opportunity?

IT'S WISE TO BE CONTENTED with your lot—today; but not to be content with today's lot tomorrow.

Questions and Answers

Ask about your troubles—help the other fellow with his. Give your name and address. For a quick answer enclose stamp for reply.

Horsepower and Steam Consumption

These cards were taken from a 14 by 42-in. Hamilton Corliss engine, 100 r. p. m., with steam gage pressure of 96 lb. Kindly tell me the horsepower and water consumption and what changes can I make on the valve gear to improve the cards? T. E.

A.—Using a planimeter, the mean effective pressure of the head end is found to be 39.167 and that of the crank end 40.833 lb., making an average of 40 lb. for the mean effective pressure.

Substituting this value in the formula for horsepower.

H.P. = PLAN ÷ 33,000, we have

H.P. = 40 × 42 × 153.94 × 100 × 2 ÷ (12 × 33,000) = 130.5

In calculating the water consumption, use the method given on page 83 of the August issue of Practical Engineer. The length of the card is 4 3/32 in. Draw the line AC parallel to the atmospheric line and find the distance AB equal to 2.75 in. The line DC equal to 2 29/32 in. The distance from the line AC to the atmospheric line is 0.5 in. The volume in cubic inches of the steam in the head end of the cylinder is equal to

2.75 ÷ 4.094 × 6460 = 4340 cu. in. at a pressure of (0.5 × 40 =) 20 lb.

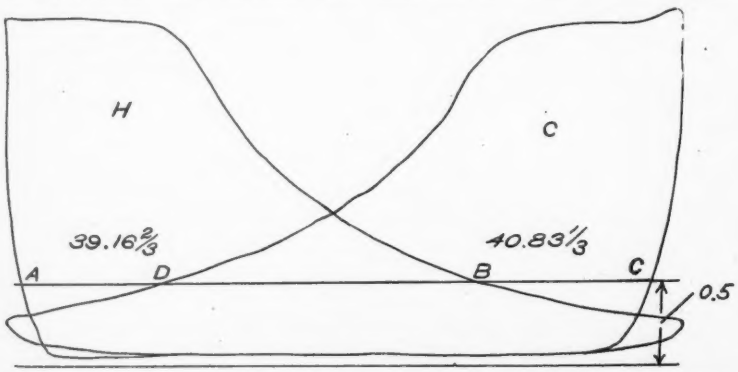
The volume of steam used in the crank end of the cylinder is found in the same way to be equal to

2.906 ÷ 4.094 × 6460 = 4590 cu. in.

The total volume is then equal to the sum of these 2 quantities or 8930 cu. in., which, divided by 1728 equals 5.17 cu. ft.

The weight of steam per cu. ft. at 20 lb. gage pressure equals 0.08507, according to the value found in the steam table. The weight of water consumed in one hour then is equal to 0.08607 × 5.17 × 100 × 60 = 2640 lb.

The cards show very good valve adjustment, but might be improved by advancing the release on both ends of the cylinder slightly and decreasing the compression on the crank end, which appears to be greater than that on the head end of the cylinder.



DIAGRAMS FROM HAMILTON-CORLISS ENGINE: 14 IN. DIAM.; 42 IN. STROKE; 100 R.P.M.; 96 LBS. INITIAL PRESSURE GAGE; 40-LB. SPRING

What Kind of Fuel

Which would be the more economical for fuel, natural gas at 9 cents per 1,000 cu. ft. or Pennsylvania coal at $1.60 per ton, to be used for generating steam in a 4,000-hp. plant? How many cubic feet of gas would be required per horsepower per hour under ordinary conditions? We have a Stirling boiler, equipped with chain grates, and employ natural draught at about 0.3 in. pressure in the furnace. What change would be necessary in order to use gas? S. D.

A.—The heat value of natural gas is about 1100 B. t. u. per cu. ft., or in 1000 cu. ft. there would be 1,100,000 B. t. u., which, at a cost of 9 ct., would make 122,222 B. t. u. per 1 ct.

By Pennsylvania coal you evidently refer to a low grade bituminous and that would have about 13,100 B. t. u. per pound. You would get, then, for 1 cent 2240 ÷ 160 = 14 lb., or 183,400 B. t. u.

Evidently the coal is the cheaper proposition in first cost.

The change required in the furnace would be to cover the larger part of the grate with firebrick, leaving only a slight amount of space for the passage of air, and to put in a firebrick mass which would hold the heat from the gas and give somewhat the same effect as the mass of coal. The firebrick is usually arranged in a baffling form so that the gas as it burns travels first along the grate in a long flame, then strikes the baffle and is turned back and goes over the top of the baffle into the combustion chamber, thus taking an S-shaped course in the firebox and being thrown after combustion upward against the heating surfaces of the boiler.

Allowing an efficiency of 70 per cent in the boiler, 90 per cent in transmission and 15 per cent in the engine, it would give an efficiency of 9.5 per cent from the fuel to indicated horsepower. A horsepower is equivalent to 2545 B. t. u. per hour, which, at an efficiency of 9.5 per cent, would call for 26,800 B. t. u. per hour in fuel, or about 25 cu. ft. of gas per horsepower hour.

Your natural draft ought to be sufficient to burn either the coal or the gas without any difficulty.

Size of Wire

Kindly give me a rule in figuring to get the size of wire for motor lines for 2 and 3-phase alternating current circuits.

Take a 10-hp. 3-phase induction motor, efficiency 89

per cent, power factor 85 per cent, at a distance of 100 ft.—S. D.

A.—The area in circular mills for the wire equals the transmission distance one way in feet times watts delivered at the receiving end, divided by per cent loss in line times the square of the voltage at receiving end. This whole expression is to be multiplied by a constant, which, for single-phase equals 2,160 divided by the square of the power factor and for 3-phase equals 2,160 divided by twice the square of the power factor. In your example, a 10-hp. motor will require $\frac{7,460}{.85}$ = 8,385. Assuming 110 volts on the line, the per cent loss in line allowable will be 5. The value of the constant is $\frac{2,160}{2 \times .85}$ = 1,500. The area in circular mils will then equal $\frac{100 \times 8,385}{5 \times 110^2} \times 1,500 = 20,650$, which will be a No. 6 wire, as shown by the wire tables on page 349 of the June issue. A No. 7 wire might answer, but it is not common to use an odd number wire in commercial work.

Creeping Induction Meter

Would some engineer who has met with a similar difficulty kindly inform me why our 2-wire G. E. induction meter, running on 60 cycles at 110 volts creeps backward when only the potential coils are connected up? O. W.

Pump Calculations

1. I have a pump 20 in. diameter, 36-in. stroke, water end delivering 1,800 gal. of water a minute against 200 ft. head. The steam pressure is 80 lb. What diameter of steam cylinder is required? How is this calculated and what is the rule?

2. What is the rule or basis for figuring the proportions in pumping an artesian well by the use of compressed air? What is the size of air compressor or number of cubic feet of air required and how is the pressure determined?

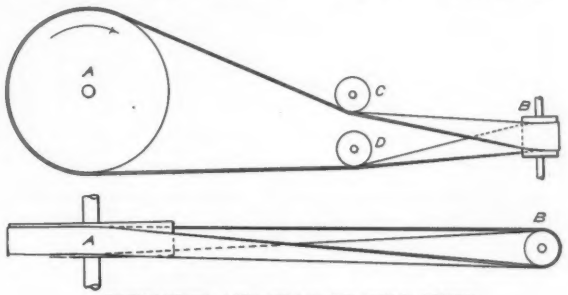
1.—200 ft. head will be 86.6 lb. pressure. This is the water head and 30 per cent should be added for friction and slip, giving a head to be provided for of 123 lb. Then the rule for the diameter of cylinders is that the water pressure is to the steam pressure as the square of the diameter of the steam cylinder is to the square of the diameter of the water cylinder; or multiply the square of the diameter of the water cylinder by the water pressure and divide by the steam pressure. The quotient will be the square of the diameter of the water cylinder. In this case $\frac{123 \times 20^2}{80}$ gives 615. The square root of this is 24.8, and the diameter of the steam cylinder would, therefore, be made 25 inches.

2.—In regard to compressed air pumping, a safe rule is that the cubic feet of free air per minute required will equal the cubic feet of water per minute times the lift of water in feet, divided by 20. The amount of pressure required depends upon the height that the water is lifted from the bottom of the discharge pipe to the point of discharge, although the bottom of the discharge pipe is way below the level of the water in the well. The depth that the end of the discharge pipe is below the water level is called the immersion and this immersion should be at least 1.5 times the lift; that is, the distance from water level to point of discharge; better 2, as this gives better economy. For comparatively shallow wells, 100 ft. or so deep, the air compressor should be 0.77 of the pressure due to the total head of lift and immersion. For deep wells, 500 ft. and over, the air pressure should be 0.62 of the total pressure due to lift and immersion. The air pipe which supplies the compressed air to the bottom of the discharge pipe should have a cross section about 1/6 that of the discharge pipe. A velocity in the discharge pipe of 20 ft. a second is recommended.

Belting Arrangement

I would like to know if the installation of the pumping plant belting shown in the sketch could be improved by setting the pulley B higher up on the shaft and setting the driver in line with it; also if the idler pulleys could be placed to better advantage.

The enginemen who made the installation claim that they are not in line for the reason that the belt running as it does on 36-in. centers from horizontal to vertical would be inclined to leave the driver A.



ELEVATION AND PLAN OF BELT DRIVE

It does not look plausible to me inasmuch as idler D is now used to correct the running of the belt. The driver makes 200 r. p. m. L. F. S.

A.—Of course with the pulley B offset from the center of A, it is necessary to have the angular pressure raised from the idler D to hold the belt on A. If the pulley B were raised so that its center line were opposite the top of pulley A, the belt would then travel to B without the use of the idler C. Of course, by using the idler C properly adjusted the belt can be carried with B in almost any position.

Action of Pump Valve; Double Eccentric Valve

1. Why are there 5 ports on each side of the steam end of a duplex pump with D valves, while there are only 3 on a common slide valve engine with D valve?

I enclose a template of valve and seat of a Knowles duplex pump, size 7.5 by 6 in. It is 5 ported with a D-valve with a large amount of lap as shown. The valve stems travel about 1.25 in., but as there is 15/16 in. lost motion on the nut the valve only travels about 5/16 in., which is about 0.5 the full port opening.

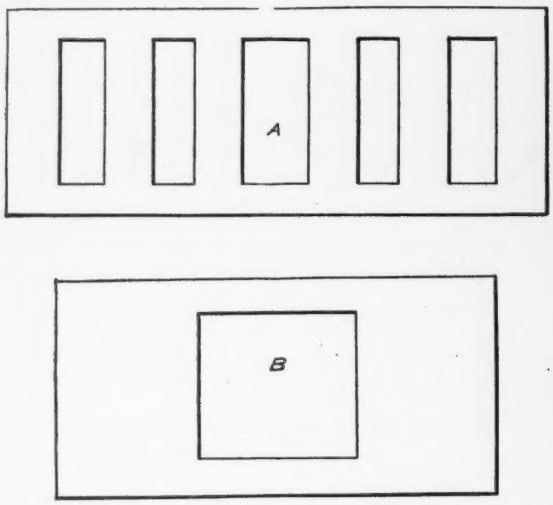
Why could not the valve be made shorter and do away with the 2 end ports?

It appears to me in this case with this type of valve that the piston gets its cushion through having the 2 end ports as the inner or exhaust port will be closed by the piston as it nears the end of the stroke, and the outer or steam port will be closed by the valve and the amount of steam still in the cylinder will be entrapped and compressed to give the piston cushion.

2. How do you get a later cut off on an engine with double eccentric than with single eccentric? Is it by changing the lap of the steam valves or by changing the position of the steam eccentric? If by changing the lap of the valves, why can't it be done on a single eccentric? E. C. W.

A.—In the duplex pump the valve used is what is known as a B valve instead of a D valve. In the D valve the one exhaust cavity answers to discharge the steam from both ends of the cylinder, while in the B valve separate ports are used for the 2 ends, these exhaust ports leading to a common exhaust pipe. This is done in order to have a smaller travel to the valve. The extra 2 ports are the 2 exhaust ports from each end of the cylinder.

If you get only 5/16 valve travel altogether, it would give you only about 5/32 port opening at each end. If you will start with the valve in the right-hand position, then steam will be coming in around the left-hand of the valve and exhausting from the right-hand end of the cylinder. When the pump reaches the end of the stroke the valve will move over 5/16 in. and steam will flow into the right-hand end of the cylinder and out of the left-hand end. When the piston has gotten over the point where it catches the steam in the



SECTIONS OF VALVE AND VALVE SEAT

outer port, you are right that it will cushion on this steam caught in the port and clearance space.

2. In an engine with double eccentric the position of the steam eccentric is changed to change the cutoff. Where there is but one eccentric, if the valve is designed for an early cutoff and the eccentric is set accordingly, it will bring the release too early and the compression too late, or it will bring the compression too early and the release too late. You cannot get all these things to tie up right.

On the other hand, with 2 eccentrics the exhaust valve can be designed and the eccentric set to give the exhaust events as you want them. The steam eccentric can then be set so as to bring the admission as early or as late as you please, and the position of this steam eccentric can be changed back and forth by the governor, if desired, without affecting the exhaust events.

DOUBLING THE HEIGHT of a chimney doubles the draft.

A BUSHEL OF POTATOES will make 6/7 of a gallon of alcohol.

EXPLOSION OF BOILERS IN A MILWAUKEE PLANT

DURING the morning of Oct. 25 there happened in the plant of the Pabst Brewing Co. at Milwaukee an explosion which has seldom been equaled for destructiveness and freakishness. The plant is a large one and the building in which the wrecked boilers were located is the latest addition to the big installation. In the plant were 6 Munoz boilers and 2 Edge Moor, the Munoz having been in use something under 2 yr. and the Edge Moor not yet having been put under steam.

As shown by Fig. 1, the boilers were located next to the stack and it is remarkable that in the course of the explosion no damage was done to the stack which

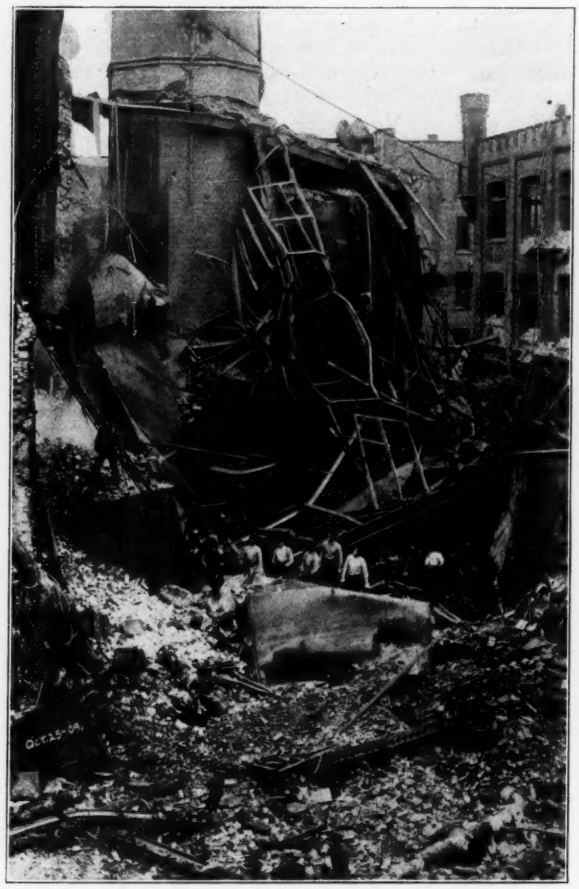


FIG. 1—VIEW SHOWING LOCATION OF BOILERS

seems to be entirely uninjured, and even the cobweb of a wireless telegraph installation which was attached to the chimney was not disturbed.

Two of the Munoz boilers and the Edge Moor units were west of the stack, the other four Munoz were on the east side and all these were exploded. As all 6 of the Munoz boilers were under steam at the time, it is probable that 1 boiler first let go and the shock of this explosion set off the other 3. Something of the force exerted can be imagined from the fact that a big malt elevator 60 ft. in height which stood near the boiler plant was moved nearly 4 ft. from its foundation and was twisted and shaken so that it may have to be rebuilt. On 10th Street, in front of the wrecked

plant, tons of brick and debris were thrown out and a drum of the boiler weighing several hundred pounds was thrown across the street 60 ft. high into a room of the cold storage warehouse.

Examination of the wrecked boilers shows that in nearly all cases the fracture was through the row of holes where the boiler tubes enter the steam drum. These drums are 3 ft. in diameter, made of steel plates ⅜ in. thick, and the joints are double butt strapped on the longitudinal seams. The reinforcing sheet is put on the outside with a single row of ¾-in. rivets, 3 in. pitch at each side and is calked to give additional strength where the tube holes are bored out. This part where the reinforcing sheet was put in for the tubes gave way, while the butt strapped joints held.

As to what caused the explosion, little is known. One story is that an 18-in. steam main to the engine room gave way and this abnormally large header gave sufficient opening to lower the pressure on the boiler plant, allowing the water to flash into steam and thus disrupt the boilers. This story was, however, disputed, and those who were in the boiler room stated that all conditions were normal at the time of the explosion. Another theory is that by some process the water in the boilers got low, permitting the overheating of the lower part of the drum in some one boiler. Whatever the cause, the result seems to prove conclusively that the water-tube boiler in large sizes must be as carefully constructed and inspected at every point as the fire-tube in order to be safe from disastrous explosion.

In this connection it should be said that the plant was inspected only 2 weeks previous by the Hartford Steam Boiler Inspection & Insurance Co., which will pay on this loss a policy of $50,000. The total destructive loss to the plant was $250,000.

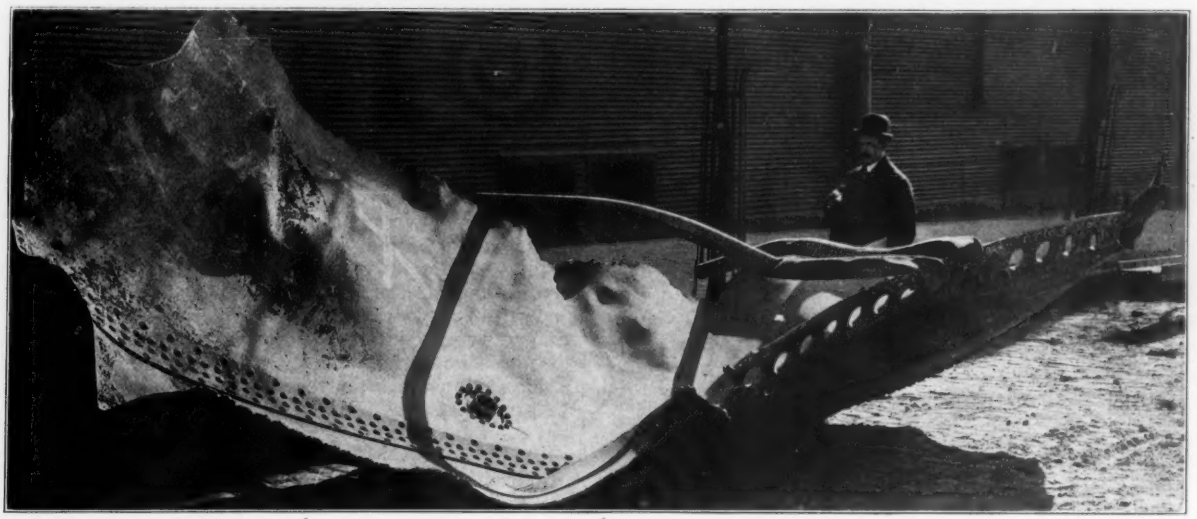


FIG. 2—BOILER PLATE SHOWING THE TEAR

CHARLES A. MILLER.

Charles A. Miller was born in Urbana, O., Dec. 30, 1848, and received his early education in the Urbana schools. As a boy and young man, he showed inventive genius. In the early 70's he manufactured wind mills in Urbana and continued in this business until 1893, when he began experimenting with gas engines, his first engine being placed on the market in 1894 and sold to the Woodward & Michael Mills of Urbana.

The next year a company was incorporated under the name of the Miller Improved Gas Engine Co. and location of the works changed to Springfield, Ohio. The company continued in the gas engine business and in 1900, the present company was organized with Mr. Miller as president, H. Over as vice-president and Dr. A. K. Smith as secretary and treasurer. The company has gone steadily forward both as to improvements in the design and increase in power of engines manufactured.

The Miller Engine is of the twin cylinder, 4-cycle type and is built in the sizes of 50, 75, 100 and 150 hp. In 1907, a 4-cylinder, 250-hp. engine was placed on the market and during the present year, Mr. Miller's last work was the designing of a 300-hp. engine which was completed before his death. Six of these engines were sold before the completion of the first one, to the Kansas Natural Gas Co. and 1 to the Jeffrey Mfg. Co., Columbus, Ohio.

Mr. Miller died on the evening of Oct. 22 at Utica, O., where he had gone on business, death being due to heart failure. He was buried at Springfield, O.

TESTS OF THE NORTH DAKOTA, the new battle ship of the United States Navy, showed it to have the highest horsepower ever attained by a man-of-war. It is a turbine driven boat, and showed a speed of 22¼ knots maximum with a maximum horsepower of 35,150. This performance places it at the head of all navies, in the lead of all battle ships now afloat.

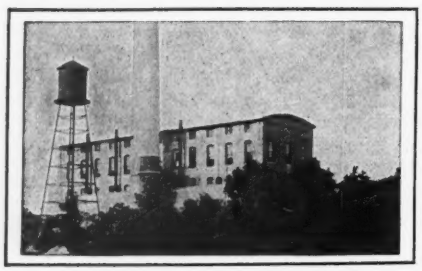
WITH THE CLOSE of the month of September, half the excavation on the Panama Canal was finished. The work is progressing rapidly, although the highest record for any one month made in March, 1909, has not since been reached.

The total up to the end of September was 87,172,058 cubic yards.

IF YOU DON'T LIKE things as they are, take them that way anyhow; you've got to. Then proceed to make them over to suit you.

"SEE THAT TODAY'S EFFORT follows up that of yesterday."

A LAUGH IS WORTH a hundred groans in any market. —Lamb.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

BUILDING UP BUSINESS*

By F. N. Witbeck

NAILS, so common to most of us, are like people, of many kinds and varieties; some with large and well balanced heads, others, though smaller, have the same faculty of getting to a point; but all will stand driving if properly driven. Some get warped and bend when driven too hard, while others, lying around, get rusty.

My first Nail will be a 60d. personality of yourself in business. Be your own chief gunner and make your salesmen able assistants by thorough training. Come in personal touch with all regular customers, meet them with the glad hand whenever and wherever place affords. There is nothing reaches that spot in inner man like a welcome handshake when backed by your personality. "I mean it," a hand that speaks, that tells one you want him to be your friend, and that he is welcome to your place of business whether he makes a purchase or not. As a commercial traveler for several years, when calling on a new merchant, I long ago learned to read him by his handshake, and the look of his eyes while so doing.

Calling on Customers

Another Nail I would drive here is to make more personal calls among your customers; take a few hours off once in a while and travel through the country among your friends; dine with them when opportunity affords, and I believe you will see your visits returned with an increase of business from that quarter.

Your Competitor Is Also a Man

The next size I would use would be to size up my competitor and make friends with him if possible. I would realize that he was in business the same as I, not as a cutthroat or an outlaw, as some dealers almost confess of their competitors, but a man just like myself, a man who is trying to make an honest dollar, just like myself, to feed and clothe his dear ones. Do this and you see him in a new light; he is a mighty good fellow, just like yourself, when you get acquainted with him.

Do this and your competitor will take a different course; antagonism will disappear, and when a customer happens to mention the name of your rival in trade you will say, "Yes, John sells a good wrench, but I believe I can show you more value in this one," and many times you will have made a sale to a party who might have been a regular customer of the other fellow. Be neighborly, be friendly to your competitors and you are but driving the nails more firmly in your own foundation.

*Abstract from a paper before the Hardware Dealers' Association.

Be Loyal to Manufacturers and Jobbers

The next plank which I wish to impress upon you the necessity of nailing down well is loyalty to jobbers and manufacturers who supply you goods. They are your friends. They want you to succeed and prosper, knowing full well that the better merchant you are the better the account, and by helping you they are but driving the nails into their own foundation more securely with increased sales. Now when you send them a rush order and when the goods arrive something is wrong, or there is a part of it short, which may be annoying to you, do not jump on them with both feet as if the fault was all theirs. There may have been something wrong with your instructions to them; possibly the fault may, in part, lie with you, as I have never seen either a manufacturer or jobber that was not more willing to rectify mistakes than the majority of us with our own customers when given a chance.

Then again, when checking up goods, are we as careful to report any surplus goods that might have got in by mistake, as we are to go after them for shortages? I'm afraid the latter is sometimes overlooked, for to err is quite human, and I am frank in saying that I do not believe there are many of our members who would overlook such matters.

As a representative of some very large concerns, I have known of some very unjust claims to be put in by certain dealers for goods short and for breakages, to their manufacturers, but on tracing the matter up have found that they were entirely innocent of any wrong in the shipment, and that the fault was either with the railroad who received the shipment or some of the lines over which it was carried, and sometimes with the dealer himself, and that the redress lay with the transportation company to whom the goods were receipted for in apparently good order.

As we are now getting down to smaller sized nails, where less pounds and more numbers are needed for our structure, I will use advertising. How do you advertise? And do you get satisfactory results from same? If not, why not? I cannot tell you how to advertise, as there are many ways, but I can tell you where thousands of your good dollars are wasted in advertising. It is because you try to cover too much surface with one application, or you put an "ad" in a newspaper and let it run for weeks without change. Others try to cover too many lines at one time, and still others will put in a very lengthy article, which, when read by the public, has said nothing.

Now it has been demonstrated beyond a doubt that all merchants are not good "ad" writers. But all can write good "ads" that will get business, if you will give this end a little careful thought and study, so that when your "ad" is published you will have made it so effective that all readers will feel like coming right down to your store to make a purchase. This is one kind of advertising that pays, and here let me give you a rule to go by: Specialize your business more.

Advertise one thing that has merit at a time and word its description so plainly and completely that it will set people to thinking and create an appetite. The object of judicious advertising is not so much to hold your regular customers as to reach out and draw new ones, and when you get them your personality and that of your salesmen should have the power to make them feel at home, and show up other new goods that possibly they had not seen. Here is where you use the Clinch Nail and clinch them so strong that they will stay with you.

Pushing Specialties

We all know that some dealers have made a success in pushing specialties, while others who have taken hold of the same articles have fallen down, and when the salesman who sold him the goods calls on his next trip he is met with: "We can't sell those goods here; they are too high priced," or "We have had no calls for them," etc. The salesman, on investigation, finds the goods packed away, sometimes in the original package. Is it then any wonder that the goods were not sold? That they were too high in price and that they were not called for? With the goods was a large bundle of samples or advertising or both, and everything necessary to help the merchant create a demand for the goods. These cost the maker money, and had they been rightly distributed all would have reaped a benefit.

If you are a progressive merchant and a salesman buy specialties. If not, buy nails. They are always in demand, if you make the price.

Making the Price

And let me call attention to the merchant who is always calling for a cheap price. It is one thing to buy cheap and quite another to buy right, and the same in selling. Too many merchants who are given to cheap buying are also shouting: "We sell cheap! We make the lowest price in town!" Why not say: "The place where you get the quality," and establish that quality in your customers' minds, and when you have done so you will not have any trouble to get a reasonable price. And when sold you have made a satisfied customer, who will be a standing advertisement for your store.

Get out these hidden away specialties, talk up and show their merit, give out those costly folders sent you, put the price to reward you, and you will soon create that demand that did not exist, because the public did not know such goods were made or that you had them.

SERVICE

Perhaps the most important thing which any merchant sells is that for which he does not make a direct or open charge. The name of this commodity is "service." Nothing on his shelves or counters is of greater value, and the quality of service which he gives his customers is just as vital to his success, perhaps more so, than is the quality of the goods which he sends out or puts into the hands of his customers.

It is not too much to say that good service is the most profitable thing which anybody can sell, and that poor service is, by the same token, the most unprofitable thing. Comparatively few have any realization of this, and seem to conduct their business upon the supposition that service is an intangible quantity. Few mistakes can be more fatal to merchandizing than this notion. From the delivery boy up to the proprietor, quality of service should be considered the very essence of good merchandizing. It is a fundamental trait of human nature to consider the manner in which a transaction is done to be quite as important as the more material part of it. Why do you go to a first-class restaurant? Not because the food served is really any better than you would get at a cheaper restaurant, but because the service is better. In other words, you pay for a superior article of attention, for more attractive surroundings. Your customers are made of the same clay as yourself, and they will, consciously or unconsciously, take this same matter of service into consideration in buying goods.—H. N. Higinbotham.

CONVERTING A GASOLINE ENGINE TO PRODUCE GAS

The following letter written by T. L. Daniel of the Seattle office of Minneapolis Steel and Machinery Co., is refreshing in its frank statement of a subject about which there is a great deal of misunderstanding among engineers. It is worth reproducing as an example of good business method and salesmanship as well as a straight forward bit of information on engineering.

"In reply to your postal of recent date we are glad to advise that we can quote you on producers for almost any known coal, but the anthracite requires a much simpler plant.

"We do not like to encourage you with the idea of trying to run your gasoline engine with producer gas. This is very much like a woman talking politics, or a dog walking on his hind legs; it is not done very well, but we are surprised and interested to see it done at all. Much careful tinkering would have to be done to the engine and at the best it would be more troublesome than ever, and if your experience is like that of many gasoline plants this is enough said. A producer would cost you from $700 to $1,000, and we would not like to see any of our friends putting this amount of money into something that would disappoint them. We are much interested in selling an apparatus, however, and trust you will appreciate our interest in frankly telling you the facts, although it means, possibly, a loss of business.

"If we can learn the number of hours you run per year and your present fuel bill, also the cost of coals and wood at your plant, it is more than likely that we can show to your satisfaction what is best for you to do. We frequently find ways for our friends to improve their plants that pay them 50 and even 100 per cent on the money they put into it, netting better returns than the money in the main business."

THERE HAVE BEEN MANY attempts to formulate an explanation of a steam turbine's operation which will be understandable by the non-technical man. One of the simplest we have seen is given by the "Daily Star" of Lincoln, Neb.

"The turbine stands about 6 ft. and is about 6 ft. through. It is cylindrical. The turbine wheels inside are used to keep the acids and zinc stirred so as to generate electricity rapidly."

This was contained in a comment on an accident to a turbo-generator. No wonder it blew up!

BELTS OUGHT TO SLIP if the strain is too great. Keep the surface clean and soft, the pulley smooth and bright, the belt large enough to carry the load easily, the hug close, and there will be little trouble from creep, slip or wear.

IF YOU TREAT a customer as if he were a guest, he will think you want him to come again, and will be likely to come.

PIPING OF HEATERS AND RECEIVERS IN CONNECTION WITH A SYSTEM OF STEAM HEATING

From the great amount of discussion and difference of opinion that have existed on the arrangement of steam piping, especially exhaust steam piping in con-

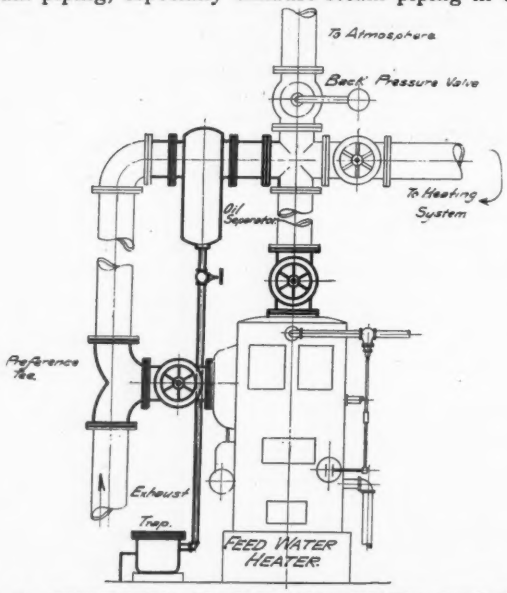


FIG. 1. CONNECTION OF COCHRANE HEATER INTO EXHAUST STEAM HEATING SYSTEM

nection with steam heating systems, 2 facts have emerged which are essential; first, the piping must be so large as not to create injurious back pressure; sec-

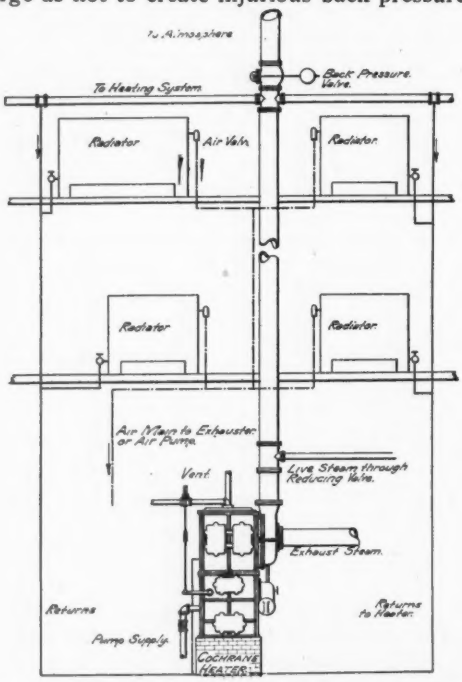


FIG. 2. THE PAUL VACUUM SYSTEM OF HEATING WITH COCHRANE STEAM STACK

ond, condensed steam and air are heavier than steam and will flow to the lowest part of a system naturally by gravity, if the flow is not obstructed by pockets or long piping of small diameter. It is then an easy matter to arrange for the removal of air from above the returned water.

Illustrations are given herewith of several arrangements which are frequently used and with good results in the handling of exhaust steam. In Fig. 1 is shown a good arrangement where the exhaust is taken by means of a preference tee into the heater and a bypass is arranged around the heater with a separator to remove oil from such exhaust steam as is not used by the heater.

This is good practice, but takes a considerable amount of piping, valves, etc. In this arrangement the independent oil separator should have sufficient capacity to purify the entire volume of exhaust steam, as it will be called upon to do when the heater is out of circuit, or when the returns come back to the heater so

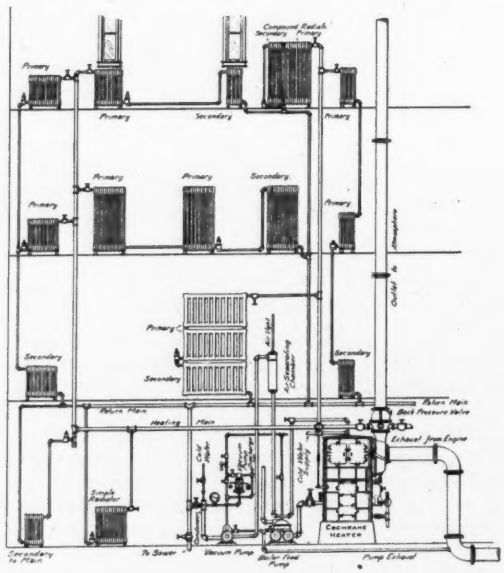


FIG. 3. SIMONDS COMPOUND RADIATION SYSTEM

hot that none of the steam is condensed. This arrangement avoids one fault frequently found, as shutting all of the valves cannot put boiler pressure into the heater, and the back pressure valve is always connected to the exhaust steam line.

In Fig. 2 is shown the Paul Vacuum System of steam heating, as installed in connection with the Cochrane Surplus Heater, which has within itself a heater, an oil separator for taking the oil out of all the exhaust and a surplus discharge line for the steam not used by the heater. In the Paul System, the condensed returns descend from the radiators in the usual manner, and discharge into the heater while air is withdrawn from the radiator by a vacuum pump or ejector through thermostatic valves which do not permit of the passage of steam.

Figure 3 shows the Simonds' Compound Radiation System in which the condensation from the steam radiators is passed through secondary radiators, in which it is cooled enough to permit of being handled readily by the vacuum pump, thus avoiding the use of any cold water injection. The escape of air from the primary radiators is controlled by thermostatic or other automatic valves.

A photographic view of the Cochrane Steam Stack and Cutout Valve Heater and Receiver, as arranged in a plant, showing the simplicity of the piping is given

in Fig. 4. As noted before, this apparatus contains an oil separator, capable of taking care of all the exhaust steam and therefore purifies the steam which passes through the heating system as well as that which is used in the heater proper. This form of heater may be used with any system of exhaust steam heating, and may be used with a hot blast heating system. In a horizontal cylindrical type, it may be used wherever the head room is so low that the usual vertical type of steam stack is not available. The Cochrane Steam Stack is made by the Harrison Safety Boiler Works, of Philadelphia.

GANDY STITCHED BELTING

The foundation of the Gandy belt is a very heavy duck woven in The Gandy Belting Co.'s duck mill according to specifications adopted by Mr. Gandy 30 yr. ago and never since changed, as exhaustive tests have conclusively proven this peculiar weave of duck best for belting purposes. It has an even strain throughout.

One of the most interesting features found in the Gandy factory is the sewing machines used. These machines were built in the factory machine shops and have patented features possessed by no other machines,

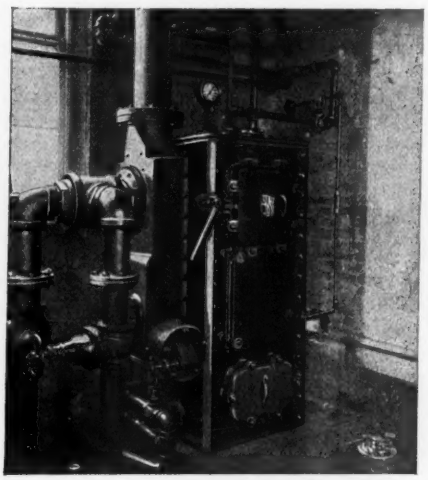


FIG. 4. THE COCHRANE STEAM STACK HEATER

one of these being that they stitch with an imbedded stitch, resulting in a smooth surface for the belt and at the same time welding the plies more solidly together.

After stitching, the belt is treated to a secret process which renders it water, heat and steam proof. With these exclusive features, the manufacturers claim to produce the most durable belt on the market for driving, elevating and conveying purposes.

One practice which is a valuable asset is the policy of shipping all orders the day received. Belt users can best appreciate this feature who have found the necessity of procuring a belt quick. For this purpose The Gandy Co. carries a stock of over 1,500 rolls of straight roll belting in all sizes from 1-in. 4-ply to 30-in. 10-ply, and for the thresher trade alone is carried a stock of more than 5,000 endless thresher belts to draw from at all times.

TO GET THE WEIGHT OF ICE closely, multiply length by breadth and by thickness, all in inches, and divide by 30; this gives the weight in pounds, to a good approximation.

NEW LINE OF CALIPERS

The line of calipers and dividers recently perfected by the L. S. Starrett Co., of Athol, Mass., has the legs drawn down from round stock, making them stiff and substantial, so that they are firm in the handling and using. The bows are extra strong, with screw and nut nicely fitted, and the tools are finished all over. They are made with solid nut only, the split nut not being found firm enough for this class of instrument. These tools run from 2 to 6 in. in length.

REGARDING BELTS AND DRESSINGS

After a belt has been in use some time, its surface takes on a glaze. This results in losses due to slipping, always accompanied by heating, and draws the natural oils to the surface, causing them to evaporate. This condition further leads to the belt's getting stiff and hard, and lessens the angle of wrap, the angle between the extreme points touched and covered by the belt on the pulley.

Without attention belts are almost sure to deteriorate as above described. Their efficiency is increased

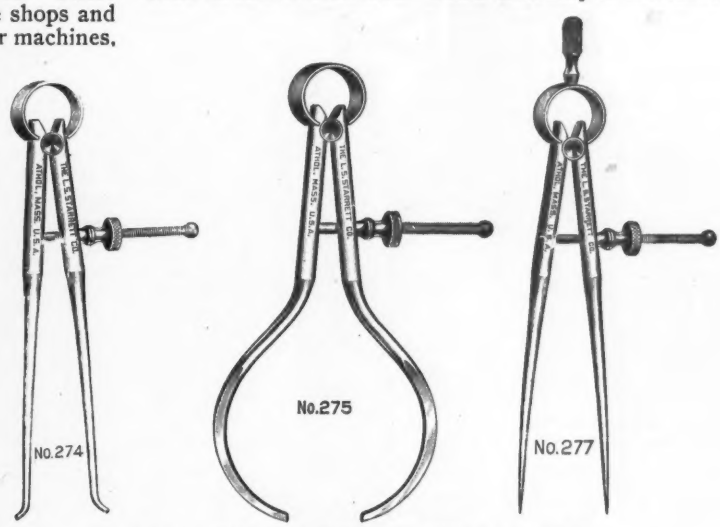


FIG. 1. STARRETT IMPROVED INSIDE CALIPERS
FIG. 2. NEW STARRETT OUTSIDE CALIPERS
FIG. 3. STARRETT TOOLMAKERS' DIVIDERS

and their life lengthened according to the treatment they receive. To prevent the formation of surface glaze and the slipping accompanying it, it is the best practice to use a reliable belt dressing. This dressing should be of a nature that will not only offer temporary relief, but that will penetrate through the surface of the belt and replenish the natural oils. This will result in keeping the belt pliable and preserving the original efficiency.

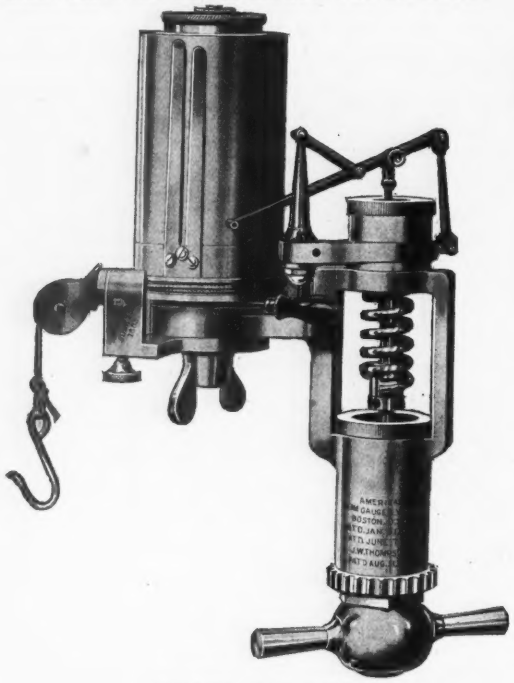
Rosin is very frequently applied to prevent slipping, and this it will do, but at the same time it destroys the life of the belt itself. You get a temporary cure but greatly shorten the life of the belt; the rosin dries out the belt and makes the leather fibers brittle.

Dixon's Traction belt dressing has through long service proved its value in preserving belts at high efficiency. It does not supply a surface stickiness but is absorbed by the belt, thus keeping it in its natural condition, preventing the formation of surface glaze with the attendant slipping, and maintaining the angle of wrap at its widest points. This dressing is the product of the Joseph Dixon Crucible Co. of Jersey City, N. J.

A NEW EXPOSED SPRING INDICATOR

The latest thought in regard to indicators inclines to the use of the exposed spring, both because of the general convenience of handling and, for gas engine work, the safety from overheating the spring.

It is interesting to note the latest development of the original Thompson Indicator, made by the American Steam Gauge & Valve Mfg. Co., which is styled by its manufacturers, "The American Thompson New Exposed Spring Improved Indicator." While this indicator has been in process of development for some time, it has but recently been placed on the market, yet has met with success and commendation everywhere and has proved itself, without question one of the most practical improvements in indicator development since the detent motion was invented.



EXPOSED SPRING INDICATOR

Among the several features of importance based on the original patents for the J. W. Thompson Indicator, the manufacturers claim as a basic cause for superior quality of the American Thompson Indicator, the short piston rod which is surrounded by the spring; the shorter the piston rod, the less liability of binding, hence the general uniformity and accuracy of results.

In the new type of exposed spring indicator, neither spring nor weight of piston rod are increased to any appreciable extent, so there is no increase in the inertia of moving parts.

Another point which will be appreciated by purchasers is that the special design of the exposed type is such that the instrument can be produced for practically the same price as the older type with enclosed spring.

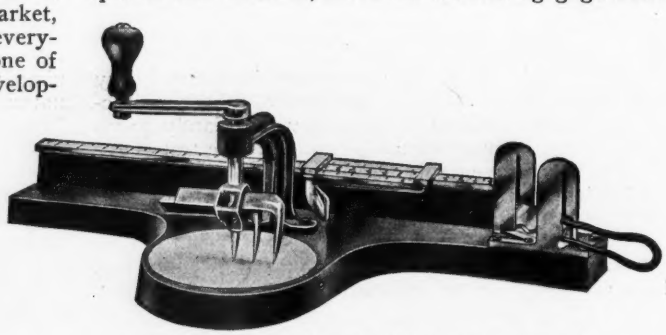
"READING IS A HELP TO THOUGHT. He who is reading and not thinking is wasting time and had better be at play."—Abbott.

WHEN SHORTENING BELTS that will not run because of too much sag, take out ½ to 1 in. for each 10 ft. of belt length.

AN IMPROVED GASKET CUTTER

In the illustration herewith is shown Brigg's improved combination cutting machine, for measuring and cutting packing, gasket rings, washers, and so forth, which is extremely simple, and can be adjusted in an instant to cut any size desired up to 5 in. in diameter.

The long gage is graduated to the diameter of the piston rod, and the short gage or adjuster is graduated to the various thicknesses of the packing. To operate this machine, move the shortening gage until



BRIGGS PACKING GAGE AND GASKET CUTTER

the size of the packing is opposite the figure showing the size of the piston rod.

This appliance is manufactured by the Pilley Packing & Flue Brush Co., of St. Louis, and is one of these handy devices which engineers always enjoy using.

THE NEW MANZEL MECHANICAL FORCE FEED OIL PUMP

This new design and addition to the Manzel line, known as the Class H Oiler, is shown in section and full view in the accompanying illustrations. It has 2 plungers, one of these drawing the oil from the

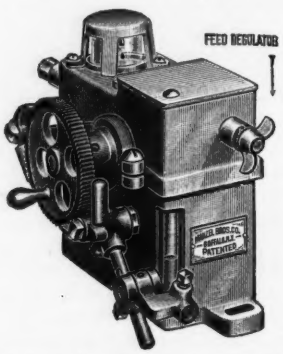


FIG. 1.—NEW MANZEL MECHANICAL FORCE FEED OIL PUMP

reservoir and forcing it through the sight glass, while the other forces it to the engine cylinder. All working parts being on the inside are out of the dust and dirt, and work in oil so that they are always well lubricated.

By attaching the entire working mechanism to the cover, it is all arranged so that it can be removed in half a minute for examination or adjustment. The feed is arranged on top, where it is plainly visible from all sides of the engine, and the amount of the feed is constant for each stroke of the plunger. By allowing the oil to drop downward through the sight glass no liquid is used or is necessary, and the sight glass can be taken out at any time without stopping the engine

or pump. This does away with all creeping of the oil up the sides of the glass, and with stopping up of the feed glass.

Feed is easily and accurately regulated while the engine is running by turning the regulating screw to right or left until the proper amount is obtained. When properly adjusted a lock nut holds the screw in place, and no further attention is required. The Class H oiler is made in the multiple feed types with each feed adjustable independently so that, from a single pump, different rates can be had for different bearings.

For use before the engine is started up, or in case more oil is needed for a time in any bearing, a hand attachment is provided, operating the ratchet wheel. In the reservoir the special features are a large strainer and filling space, a gage glass showing the amount of oil in the reservoir, a perfectly plain and smooth exterior which is easily kept clean and has a handsome appearance, and first-class material and workmanship throughout. The Manzel pump is made in sizes from 1 quart to 1 gallon with 1 to 6 feeds, and is finished in a heavy nickel plate fitted with ¼ inch pipe.

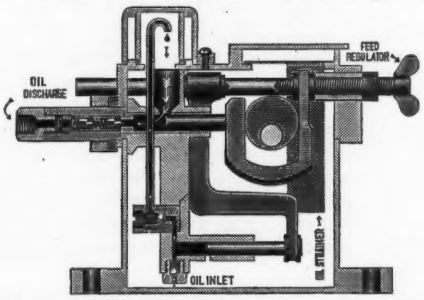


FIG. 2.—CROSS-SECTIONAL VIEW OF OIL PUMP

The makers, Manzel Bros. of Buffalo, N. Y., show their confidence in the ability of this pump to please, by offering to send it on 30 days' trial to any responsible person, returnable at their expense at the end of the trial, if not found satisfactory.

The single feed pump is made in 1, 2 and 3 quarts, the double feed in 2 and 3 quarts and 1 gallon, triple feed in 5 pints, 3 quarts and 1 gallon, quadruple feed in 3 quarts and 1 gallon, and the 5 and 6 feeds in 1 gallon sizes.

NEWS NOTES

DECEMBER 7 TO 10 the 30th annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 W. 39th street, New York. The professional papers assigned to the meeting are as follows: "Tests on a Venturi Meter for Boiler Feed," Chas. M. Allen; "The Pitot Tube as a Steam Meter," Geo. F. Gebhardt; "Efficiency Tests of Steam Nozzles," F. H. Sibley and T. S. Kemble; "An Electric Gas Meter," C. C. Thomas; "Tan Bark as a Boiler Fuel," David M. Myers; "Cooling Towers for Steam and Gas Power Plants," J. R. Bibbins; "Some Studies in Rolling Mill Engines," W. P. Caine; "An Experience with Leaky Vertical Fire Tube Boilers and the Best Form of Longitudinal Joint for Boilers," F. W. Dean; "Testing Suction Gas Producers with a Koerting Ejector," C. M. Garland and A. P. Kratz; "Bituminous Gas Producer," J. R. Bibbins; "The Bucyrus Locomotive Pile Driver," Walter Ferris.

ON DECEMBER 15, examination will be held by the United States Civil Service Commission at the larger cities throughout the country for an assistant steam engineer, at a salary of $1,080 a year, for the National Museum, in Washington, and one for the Smithsonian Institution. Any citizen of the United States, 20 yr. of age or over, is eligible, but must show in the application that he has actually lived in the state or territory where he now resides, for at least 1 yr. previous to examination, and must be examined in that state or territory.

The examination will be on Letter-writing on some Mechanical or Electrical Subject, Practical Questions in Mechanical and Electrical Engineering, particularly on the operation of heating and lighting, and elevator machinery, and experience in mechanical and electrical work will also count. Applicants should apply to the Civil Service Commission, Washington, or to the Secretary of the Board of Examiners in any of the large cities, for Form 1093, which must be properly executed, and filed with the Commission at Washington, in time to allow shipment of examination papers.

Another examination will be held on January 5, '10, to secure a first-class steam engineer, upon the same subjects mentioned above. The salary in this case to be $1,600 a year and applicants should send for application Form 1312.

IN FUTURE THE McLeod & Henry Co., of Troy, N. Y., which manufactures Steel Mixture, boiler setting material, will be represented in Chicago and vicinity by Stephen Christie. Mr. Christie's large acquaintance among the engineering profession and wide experience in the handling of boilers, fit him eminently for assisting in the solving of boiler room problems, and giving good advice about boiler settings. His office will be at 171 La Salle street, Chicago.

C. N. MANFRED, formerly with H. W. Johns-Manville Co., of 100 William St., New York, has resigned his position as manager of the advertising department of that company to become secretary of the Willett Press.

THE MONTHLY PUBLICATION Steam, devoted to the steam specialty trade, has been purchased from the Gage Publishing Co. by the Ferguson Publishing Co., 114 Liberty Street, New York, and will henceforth be published under the latter name, beginning with the current issue. This company has also purchased the Architects and Automobile Editions of the Buyers Reference.

NOVEMBER 30 TO DEC. 2 there will be held at the La Salle Hotel, Chicago, the fall meeting of the National Gas and Gasoline Engine Trades' Association. Election of officers will take place, and a number of interesting papers will be read. H. W. Jones of the Peoples Gas, Light & Coke Co. will have in charge the entertainment features of the meeting.

Papers to be read at the meeting of the National Gas and Gasoline Engine Trades Association, will include the following: Associations and Experiences; The time length of contract with special reference to marine engines; Carbureters; Factory Costs; Bearings for Gas Engines; Storage Batteries; The Gas Engine Business from the Dealer's Standpoint; Gas Engines, Their Adaptability, Their Reliability, Their Economy, Relationship Between the Gas Engine Salesman and the Buyer; Adaptability, Reliability and Economy of Illuminating Gas; Dimensions, Weights, Grades and Feed of Large Gas Engines; Gas Producers; The Work of the University of Illinois Experiment Station.

Sessions will be held morning, afternoon and evenings, Nov. 30, Dec. 1 and 2, the last session on Thursday being in charge of the entertainment committee of which H. W. Jones of the People's Gas Light and Power Company, of Chicago, is chairman.

The technical meetings are open to all interested and those in charge of plants will find it well worth while to attend.

THE RIDGWAY DYNAMO & ENGINE CO. announces the opening of a district office at No. 1311 Schofield Building, Cleveland, Ohio. H. C. Hale, who has been the Cleveland sales agent for "Ridgway" apparatus during the past 2 or 3 years, will be in charge of this office as local manager. Mr. Hale is well and favorably known in Cleveland as an able engineer and has been connected with several of its important engineering and manufacturing enterprises. While his experience has thus been varied, he has had special opportunities for observation and study of the many problems connected with the mechanical and electrical equipment of the coal mines in the bituminous fields of Ohio, Pennsylvania, West Virginia and Kentucky. The Ridgway Dynamo & Engine Co. supplies a large proportion of such power house equipment for the mines in these districts and considers itself fortunate in having Mr. Hale on its staff.

E. C. SORNBORGER HAS BECOME identified with Allis-Chalmers Co. in the capacity of a sales engineer in its pumping engine and hydraulic turbine department. The acquisition of Mr. Sornborger is an indication of the policy of the company to obtain men of recognized standing in their respective lines,—the engineering profession, and especially water works engineers, among whom he has an extensive acquaintance, having long regarded Mr. Sornborger as a man of exceptional ability and experience, both practically and commercially.

Mr. Sornborger received his early training and practical experience in the shops of the United States Navy, where he was later appointed a cadet engineer. Shortly after he was enlisted in the merchants' service as assistant engineer, in which position he remained for a number of years.

Attention has frequently been called to the value of the navy as an industrial school, and this is reflected in the engineering career of Mr. Sornborger; while his subsequent work with the Buffalo Steam Pump Co., Gordon Steam Pump Co., and the Snow Steam Pump Works, emphasizes its value commercially.

Lieutenant Sornborger still retains his interest in naval affairs, being the commanding officer of a division of the Naval Militia of Buffalo.

THE ENGINEERING INDEX ANNUAL FOR 1908

Whenever one undertakes to investigate a special subject, one of the most valuable sources of information is the files of technical journals, but the difficulty of getting at this information is great unless there is available some source of information which will show where articles on the desired subject are to be found.

The Engineering Magazine in its publication of the Engineering Index Annual, does the world a great service as it makes available practically all important articles in the technical publications, for the reference of those who may be undertaking such investigation.

The annual for 1908 is fully up to its predecessors, which is sufficient praise for any book. The leading journals of Germany, France, England, United States, Canada, and the papers of the engineering societies of all countries are indexed. The book is divided into 8 general subjects, Civil Engineering, Electrical Engineering, Industrial Economy, Mechanical Engineering, Mining and Metallurgy, Railway Engineering, Marine and Naval Engineering, Street and Electric Railway. Under each division are suitable subheads, for quickly locating any desired subject and under each subhead alphabetical arrangements are adopted for the different topics.

The reference in each case gives the title of the article, the author, a brief outline of the subject, the number of words, the date, and a serial number by which the article is known. This serial number may be used to order the article complete from the Engineering Magazine, if so desired, or the articles can, of course, be found in any large library by referring to the bound files of the magazines.

The scope of the work is shown by the fact that the volume for indexing the periodicals of 1908 contains 437 closely printed pages and the fullness of the indexing can be seen from the fact that the subject of dynamos and motors takes up 9 pages and the subject of steam engineering takes up 21 pages.

The price of the book is $2 in substantial cloth binding.

BOOK REVIEW

STEAM POWER PLANT PIPING, by Wm. L. Morris, New York. Cloth Binding, 490 pages, Illustrated, price $5.

Piping is one of the subjects which has been treated but incompletely and very often, incorrectly. It is therefore, gratifying to find a complete treatise on the subject, and one written by a man who is well equipped because of experience, to speak on the subject, and who is able to put his ideas into clear and understandable form.

Mr. Morris has had years of experience in the design of power plants and has embodied in this book, the result of his experience. It embodies, however, not only methods of design and installation, but ideas in regard to repairs, kinks and troubles required in the maintenance. It divides up the subject into How to Lay Out the System, which is the main consideration, and then speaks of details under the headings, Condensers and Heaters, Live Steam Systems, Blowoffs and Exhaust, Air and Oiling Systems, Oil and Water Systems, Live Steam Details, Exhaust Details, Boiler Feed Details, Details on Water Piping of different kinds, Details on Air Lines, Steam Drip Lines, Oil Lines, Blowoff and Sewer Connections. The author points out not only what to do, but the pitfalls which lie in the way of the inexperienced designer or the young engineer, so that the "what not to do" which is quite as important often as what to do is understood.

Cuts for the book have been prepared from sketches made by the author, and are therefore of the kind which really illustrate and supplement the text. It is difficult in a short outline to give an idea of such a book or to criticise it in any adequate way, in fact, there is no criticism to be offered, nothing but praise, and the best advice we can give to those interested in the subject of steam piping is to get the book and read and study it carefully.

A PAMPHLET on the prevention of industrial accidents, issued by the Fidelity and Casualty Co. of New York, is of special interest to engineers, as it treats of safety devices for steam boilers, engines, electrical apparatus, elevators and other machinery. Rules on the strength of boilers are given, the merits of different constructions and methods of operation are discussed, and precautions which ought to be taken are suggested. The price in paper covers is 25c, and it is well worth the money.

THE SLIDE RULE, by J. J. Clark, of the International Correspondence Schools, at Scranton, Pa., is a treatise designed specially to make clear to engineers how the slide rule is used by explaining fully a few of the leading principles, and explaining them so that they cannot be forgotten. The book takes up each operation by itself, fully, and discusses it carefully, giving illustrated examples and reasons, so that the understanding is complete, and likely to be remembered. The book will be

found useful not only by the beginner, but also by others who have not solved all the possibilities of the slide rule in computation.

A COURSE IN PRACTICAL ELECTRICITY FOR HOME STUDY, in 12 lessons, has recently been completed by Joseph G. Branch, and is being put on the market by the Branch Publishing Co., of Chicago. Mr. Branch is well known as the author of Stationary Engineering, Conversations on Electricity, and other engineering works, and in the lessons for home study has sought to put into concise and convenient question and answer form the information that an engineer needs in operating his machinery. It starts with the elementary principles of electricity, explaining both static and dynamic forms, and carries the work on through the measurement of energy work and power, the use of batteries, the relation between electricity and magnetism, the dynamo and its parts, the properties of alternating currents, and alternating current machinery, electric motors as used for factories, railways, and other work, and electric wiring requirements. The special introductory offer which is now being made, gives to those who take up the course early, a decided monetary advantage. The course is given in 12 lessons, two being sent each month to the student, bound up into one book.

PRACTICAL ARMATURE AND MAGNET WINDING. By Horstmann and Tousley. Chicago, 1909; 231 pages; leather binding, pocket size; price, $1.50.

Anybody who has charge of generators or motors and needs to repair them will find this book of great value as a reference in times of doubt. It was written by practical men and is full of illustrations and diagrams, showing the most economical and best way of performing the operation described.

The elements of armature design are taken up in the first part of the book, giving both the electrical and mechanical considerations which affect the operation of the armature. Following this is a description of armature diagrams taking up, in separate chapters, the ring and drum armatures, describing in detail the methods best adapted for winding armatures of either the wire or form wound type.

A complete chapter is given up to the description of commutator construction explaining the modern methods of insulating and securing the bars which should be of considerable interest to engineers. Following this is a chapter on armature troubles which are common to direct current armatures, and the best method of detecting and remedying them. In another chapter are given the necessary calculations for designing a complete armature for direct current work.

The chapter on magnet winding takes up the design, type and winding of various forms of magnets from the door-bell to the heavy lifting magnet. The final chapter of the book is devoted to formulas and tables which are frequently used by engineers and electricians about a power plant.

The book is completely indexed and would be of value to any engineer as a hand reference book.

MANUAL OF STEAM ENGINEERING, by W. H. Wakeman.

Mr. Wakeman's name and writings are familiar to readers of Practical Engineer, and this little book, which has been compiled especially for the use of the men in the engine room, will be found up to the high standard of his previous work. It is designed especially to give information necessary for specifying boilers, boiler feed pumps, steam engines, injectors, and other equipment which go to make up the modern high efficiency plant. It is clear, concise and well supplied with tables such as are wanted by busy men for everyday work.

Starting with the subject of boilers, it takes up the matter of riveted joints, proper thickness of shell, bracing of heads, strength of flues, heating surface required, methods of testing, and gives tables of the properties of water and saturated steam. It then deals with the different methods of feeding the boiler, such as power pumps, direct acting steam pumps, their size and capacity, and the methods of arranging pumps for boiler feeds.

The theory of action of the injector, the capacity of injectors and the details of construction are clearly shown, and the best methods of arranging injectors for boiler feeding.

On the subject of steam engines the method of figuring horsepower is shown, and tables of circumferences and areas of circles and hyperbolic logarithms are given for use in computing horsepower. Tables of mean pressures at different cutoffs, and initial pressures, tables of horsepower constants, tables of horsepower of different size engines for given speeds and cutoffs, and description with tables of the method of getting the horsepower of compound engines, help to make the subject easily understood and to simplify the work.

A final section is devoted to practical pointers for power plant operators such as packing the covers for manholes and handholes, smoke consuming devices, methods of draining steam pipes, lining up an engine and adjusting bearings and crossheads, and at the end is a convenient index which gives quick reference to tables and text.

The book is well illustrated with the needed diagrams, has over 400 pages and is of convenient size for carrying in the pocket. It is substantially bound so that it will stand long and continuous service. As to how it may be obtained, it has been published by the New York Belting and Packing Co., of 91 Chambers St., New York, for distribution among the company's friends, and an application sent to that address will receive prompt attention.

METAL SPINNING, by Fred D. Crawshaw, 72 pages fully illustrated. Cloth binding, Chicago, 1909. Price 25c.

This is about the only book available on this fascinating art of spinning vessels of all kinds from flat plates of metal. It gives a description of the tools to be used, the methods of going about the different kinds of work, and precautions that should be taken in the handling of such work in order to achieve success. Bowls, vases, candlesticks, trays, are among the artistic things which are shown and for which instructions are given.

THE STANDARD GUIDE FOR LOCOMOTIVE ENGINEERS AND FIREMEN, by Ed. Turner, Chicago, 1909, 198 pages fully illustrated. Vest pocket size in full leather binding, price 75 cents.

In this compact form is given the information that is most important for engineers and firemen, handling locomotives, to know and to have at hand. It covers the action of Air Brakes and Air Brake Pumps, The Injector, the Arrangement of Cylinders and Valves for different styles of compound engines, the action of the Walschaert Valve Gear, the remedying of pounds, knocks, steam blows and break downs, Standard Rules for Engineers, Codes of Signals by whistles, lanterns, torpedos and colors, and an explanation of the relation between standard time and sun time.

It is well written and clearly illustrated, and is well worth while.

ENTHUSIASM IS THE driving force of character. The man who lacks it has lost the race of life before starting. —Exchange.

CATALOG NOTES

CATALOGUE 15 DESCRIBING the Improved Dexter Valve Machine made by the Leavitt Machine Co., of Orange, Mass., is attractive from cover to cover. The cover is attractive because of the beautiful design and tint work on it and the inside is attractive not only from the fine job of printing, but because of the interesting facts that are told there, and the interesting Labor Saving Machinery which is described.

The Dexter machines are made for reseating all kinds of valves with all sorts of seats, and for recutting valve discs. The catalogue tells how this is done and how valves may be saved even when they seem in very bad condition. A special form of machine is shown also for refacing pump valves.

FROM THE RIDGWAY DYNAMO AND ENGINE CO. comes Bulletin No. 16, giving a list of the users of the McEwen-Thompson-Ryan generating unit, also a series of interesting bulletins describing in detail the direct-current generator of Thompson-Ryan design, the adjustable cutoff engine of McEwen, the single-valve, center crank engine, and the single-valve automatic engine. In each bulletin the details of the machine described are fully illustrated and explained and the whole series makes a most attractive addition to one's library.

SEVENTY-FIVE YEARS OF ENGINE BUILDING not only describes the facilities of the C. & G. Cooper Co., Mt. Vernon, O., for the building of steam and gas engines, but shows also in attractive illustrations, the evolution of power machinery from hand and horse haulage up to the highest modern types of engines. It is not a long and dry treatise, but though it covers a period of three-quarters of a century, it can be read from cover to cover in 15 min. Much more time than this, will, however, probably be spent on it by anyone who is fortunate enough to get it, as the illustrations are well worth careful study, and are so attractive that they hold the reader's attention. It is best to let the reader get his own pleasant impression from the book, but some of the facts told in regard to the policy of the company towards its employes, and the prosperity of the men who own their own homes near the works, are valuable from the standpoint of the man interested in humanity, as well as from that of the man interested in power plant machinery.

Fine catalogue work is no novelty in this period of extensive advertising, but the Cooper book in its artistic conception and carrying out is worth more than a casual greeting. It is available to those who are interested, by writing to the company for it.

JAMES McCRAE & CO'S. lively red catalog ought to be a business getter. It is cheerful and inspiring from the moment you look at the cover until you have turned the last page. It tells about pipe repairs, and steam specialties, the particular new things described being the Emergency Pipe Saddle, the Skinner Valve Reseating Tools, the Perfect Valve Discs, and the Butman Flue Rods, and Rod Joints. It can be obtained from James McCrae & Co., 558 Washington Blvd., Chicago, on request.

THE HANDSOME RULE SENT FREE by the Lunkenheimer Co., of Cincinnati, O., to those in attendance at Columbus will certainly be long preserved as a serviceable tool by those who get one. It's a 2-ft. steel rule, folding to 3 in. long and with a leather pocket case. One side is etched in 16ths inch, the other in millimeters. It's made by Keufel & Esser, therefore accurate. Readers of Practical Engineer will be well rewarded by writing for one.

BELT AWLS FOR BORING HOLES AND LACING leather and rubber belting are a mighty handy tool to have around the shop. The Lothrop Awl made by Greene Tweed & Co., has a number of advantages; for instance if the awl is turned to the right, a hole is cut in the belt, while if it is turned to the left, the hole already cut is simply swelled out larger. It serves not only to cut the holes but to pull the lacing back and forth, thus doing the whole operation with a single convenient tool. It is described in a folder just received from Greene Tweed & Co., 109 Duane St., New York.

HOPPES FEED WATER HEATERS, Purifiers, Steam Separators, Oil Eliminators, and Exhaust Heads, constituting the Hoppes line of steam specialties, which are based upon Nature's principles, are fully and interestingly illustrated and described in a handsome catalog issued by the Hoppes Mfg. Co., of Springfield, Ohio. Two striking illustrations, showing the necessity of such apparatus, are a pan taken from a Hoppes Live Steam Feed Water Purifier, after a 3-weeks run, and a man holding a section of scale as chipped off of this pan, which from the proportions must be at least 2 in. thick. The catalog has too many interesting features to describe them here, but can be had by writing to the Hoppes Co. at Springfield.

FROM CHAS. A. CLAFLIN & CO., of Boston, Mass., comes a most interesting catalog, with handsome embossed cover, describing in detail the Comet Steam Tube Cleaners, the Volcano Vacuum Tube Cleaners, the Sure Hold Patent Hose Fittings, the Sure Hold Patent Hose Mender, and the Telescope Patent Automatic Balanced Valve.

THE GENERAL ELECTRIC CO. has recently issued publications as follows:

Bulletin No. 4677 contains data relative to the Sprague-General Electric Type M system of control and forms a revision of similar data contained in a previous bulletin on this subject. The publication contains numerous illustrations showing the various pieces of apparatus used in connection with this system, with a description of each. It also contains a table of weights of this style of equipment for various horsepower capacities. The bulletin is one of general interest to railway men.

Bulletin No. 4675 describes and illustrates a new single-phase induction motor of the repulsion induction type, designated as Type "RI," and developed by the General Electric Co. for use in connection with installations where the starting torque of the resistance reactance type of induction motor will not meet the demand of the driven machine, or where within certain limits variable speed is required. The bulletin mentions various applications of this type of motor, illustrates and describes controllers for use in starting and controlling the speed, and contains certain other data including diagrams of connections.

No. 4,674 illustrates and describes its polyphase induction motors and the controlling apparatus for use with them. An interesting illustration in this bulletin is that of a 6,000-hp., 6,600-volt induction motor installed at Gary, Ind.

Bulletin 4,679 describes a new line of commuting pole constant speed motors which the company is placing on the market. These motors are made in both slow and moderate speed types, in capacities of from 20 to 250 hp. in the former, and 30 to 350 in the latter. They can be operated entirely open, semi-enclosed, or totally enclosed, and may be installed on the floor, wall or ceiling. The bulletin gives a detailed description of these motors.

No. 4,673 describes the Pittsburg, Harmony, Butler and New Castle 1,200-volt D. C. railway. The bulletin contains numerous illustrations and gives a more or less detailed description of the road, its equipment and operation, and should be of interest to railway men.

Nos. 3,846 and 3,847 refer to the voltage regulation of feeder circuits and generator circuits, respectively. These folders describe briefly the apparatus used in accomplishing this regulation, and state the advantages to be derived from its use.

No. 3,841, entitled "A Revolution in Lighting Due to a New Lamp," tells in a simple way the advantages to be derived from the use of the tungsten lamp.

FOR THE CONSTRUCTION OF ROOFS AND BUILDINGS, the J. M. Asbestoside, made by the H. W. Johns-Manville Co. of New York, has many advantages. It is fireproof, weatherproof, never needs painting, is not affected by acids, gases or chemical fumes, and by the introduction of some battans, as in the case of a cement house, may be given the appearance of stucco finish, so that an extremely artistic building may be made from it. What it is and what it will do are told in a booklet just received from the Johns-Manville Co.

PRESSED RADIATORS are a novelty in the heating field. Their lightness commends and they have some novel adaptations, as for instance on direct-indirect work. The new catalog of the Pressed Radiator Co. of America describes them.

THE LAGONDA MFG. CO., Springfield, Ohio, has just issued a 48-page booklet describing its Weinland boiler tube cleaners. Full description is given of the various types of cleaners manufactured by this company and the scale condition for which each is best suited is pointed out. Among the new types developed are the air and steam driven turbine and also a line of cleaners for use in condenser and economizer tubes. A description is also given of the different styles of cutter heads which are adapted for different conditions of scale. Their new device for cleaning Stirling boilers, also described, is a great time saver.

THERE ARE CERTAIN FUNDAMENTAL THINGS that we are always wanting to know, and it's mighty handy to have them by us in convenient form. That's why the Erie Engine Works of Erie, Pa., have rendered such a big service to us all by compiling the Engineers' Handbook, for it gives in handy pocket form, short, clear directions for valve setting, slide and Corliss, calculating horsepower, calculating speed of pulleys, power of belting, figuring lap and lead, economy of pipe covering, caring for dynamos, inspection of boilers, size of chimney needed, and power of ropes. The fact that it can be had for the asking doesn't alter the other fact that it would be worth buying if you couldn't get it without. A letter to the Erie Engine Works, Erie, Pa., mentioning Practical Engineer, will bring the Handbook to you.

FROM THE H. W. JOHNS-MANVILLE CO. comes a new folder showing the advantages of the Leak-No Metallic Compound for the mending of all kinds of iron machinery, including radiators, boilers, piping, stoves, pump cylinders, and anything else made of iron. It tells also the advantages of H-O Pipe Joint Cement for making tight joints and keeping them permanently tight.

KENDRICK VALVE & WASHER CO., of Syracuse, N. Y., makes steam and hydraulic packings and describes them fully in a handsome little catalog which has just been received. It shows cup packings, flange packings, extra heavy standard coupler packings for hydraulic tanks, and explains how packing leather should be cut.

THE GOULD'S CALENDAR just received is a reminder of the advantages of Rotary Hand and Power Force Pumps, made by the Goulds Manufacturing Co., of Seneca Falls, N. Y.

FROM THE DETROIT LUBRICATOR Co. comes a folder, giving description and list prices of the Detroit boiler trimmings, which include self-cleaning water Gauges, Fusible Plugs, Compression Gauge Cocks, and Expansion Tank Trimmings.

THE ADVANTAGES OF CENTRAL STATION HEATING TO ELECTRIC COMPANIES, is the title of an interesting paper read before the New England Section of the National Electric Light Association's summer meeting at the Wentworth Hotel, Portsmouth, N. H., by Chas. R. Bishop, of the American District Steam Co. This is reprinted in Bulletin No. 116, issued by the American District Steam Co., Lockport, N. Y., and gives much valuable information in regard to the possibilities of getting income from the exhaust steam of a power plant.

"A REVOLUTIONARY SYSTEM of Cylinder Lubrication," is the title of a booklet issued by the Ohio Grease Lubricant Co., which shows the method used by the Ohio apparatus for utilizing grease as a cylinder lubricant. It is an interesting booklet and describes a real novelty in the line of cylinder lubricating devices.

IF YOU HAVEN'T SEEN CATALOG H, for 1909, of the National Tube Company, you have missed something. It is one of the finest books ever put out for any purpose, and shows throughout its entire makeup the same great care which is given to the product of the National Tube Co. It is impossible even to enumerate the articles which are described, but the title page states that it embraces, Wrought Pipe for Steam, Gas, Water and Air; Cast, Malleable Iron and Brass Fittings; Brass and Iron Body Valves and Cocks; Radiators and Coils; Drive Well Points and Well Supplies.

As to its makeup, it is printed on a heavy grade of coated paper, in black and a peculiar shade of green, which has been found after a good deal of experiment to be the most easy and restful on the eyes. Pages which illustrate the Kewanee Union are printed in three colors, black, green and brass color, to show the construction of the union. The binding is of the finest, and the finish in every way is tasteful and attractive.

Not the least useful feature of the catalogue is the index on which a large amount of time was spent, getting cross references, to make the finding of any article, under whatever name it might first occur, easy and quick. Products of the company are illustrated by retouched photographs, and by wash drawings of interiors and sections, so that an accurate idea of the article is secured. It is about the dandiest and most complete catalogue that one could imagine and is one of the valued books in ye editor's library. We recommend it heartily in every respect.

"HOW TO UTILIZE EXHAUST STEAM" is the sub-title of a catalogue of the Cochrane Open Feed Water Heaters which has just been issued by the Harrison Safety Boiler Works, 3144 North 17th street, Philadelphia, Pa. The title is well justified by the fact that fully ⅔ of the book is occupied by discussions and illustrations of different ways of employing exhaust steam, as for heating, drying evaporating, heating water for boiler feeding and for use in dye works, tanneries, bleacheries and paper mills, etc. The book contains 104 pages, 6 by 9 in., and is distributed gratis to those interested in steam plant matters.

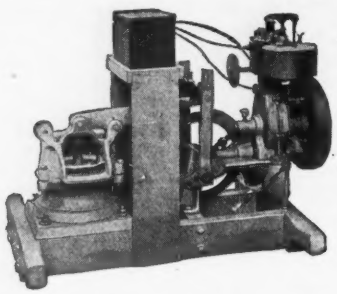
IN CATALOGUE 10 just issued by the Pilley Packing and Flue Brush Mfg. Co., of 606 So. 3rd St., St. Louis, is found a handy Pocket Compendium of Engine Room Supplies, which will be found of the greatest convenience in choosing such material. The views in the factory and the office give a good idea of the large facilities which the company has, for turning out high class goods, and quickly filling large orders as well as small ones. Some of the specialties described in the catalogue may be noted as Pilley's Copper Metallic Packing, Black Bestos oval rod packing with rubber core, the Combination Packing for rods on ammonia compressors, steam cylinders and valves, hot and cold water plungers, pump rods, and pump pistons; Black Bestos and Asbestos Sheet Packing, The Briggs Packing Gauge and Gasket Cutter, Flue brushes and scrapers, scraping packing tools, McCrea steam joint and pipe clamps, and Graphite Treated leathers for cup flange and U packings.

TRADE NOTES

FULLER & JOHNSON, MADISON, WIS., are in receipt of hundreds of letters from users of their Diaphragm Bilge Pump Outfits, expressing whole-hearted satisfaction at the marvelous work of which this truly wonderful outfit is capable.

The pump actually does 2 men's work at a mere fraction of their pay. It is attracting favorable attention from contractors, builders, railroads, ship and barge owners, or public works. Wherever economy of time and money are important factors this mechanical marvel is destined to play a very important part.

The only attention required by this engine is that of feeding it the necessary gasoline and lubricating oil. It



can be operated at about 2 c. an hour and runs for long periods with scarcely any up-keep. Those who have tested it say that it quickly pays for itself.

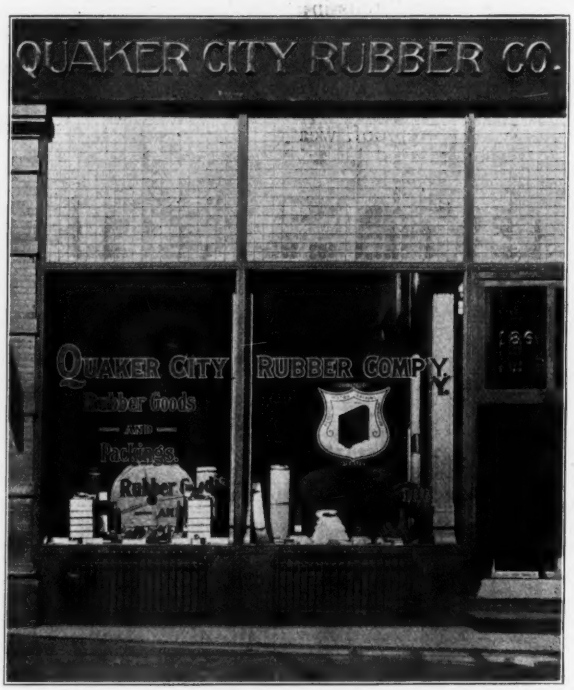
Contractors who must raise large quantities of water in the course of their work will do well to investigate this new type of engine.

T. F. FULKERSON OF SAPULPA, Oklahoma, has recently purchased a gas engine generator set from Allis-Chalmers Co. The engine is of the standard 4-cycle double acting tandem. It is rated at 360 hp. when making 200 r. p. m. and will operate on natural gas from the Oklahoma belt. The frame and slide are cast in 1 piece and is extremely heavy as are all the essential parts of the machine. The generator, which is direct connected to the engine, is a 60-cycle, 3-phase, 2300-volt machine. The exciter is belted to the generator and develops 120 volts.

BIGNALL & KEELER MANUFACTURING CO. of Edwardsville, Ill., reports that October was the best month of the year for the company, that business is getting better all the time and that every indication points to the next year being a good one for all kinds of business.

IN A RECENT ADDRESS on Business English at Tufts College, Walter B. Snow of Boston, chose the modern advertisement in its display of force, terseness, knowledge of subject and consideration of the person addressed as typical of the elements to be embodied in commercial intercourse and in technical reports, articles, etc.

THE QUAKER CITY RUBBER CO. has an attractive window display of its hose, packing and other rubber goods at its branch office in Chicago, 186 Lake St. Daniel's P. P. P. packings have won an enviable



reputation which is due to their excellent qualities and the methods the company employs to put its goods before engineers.

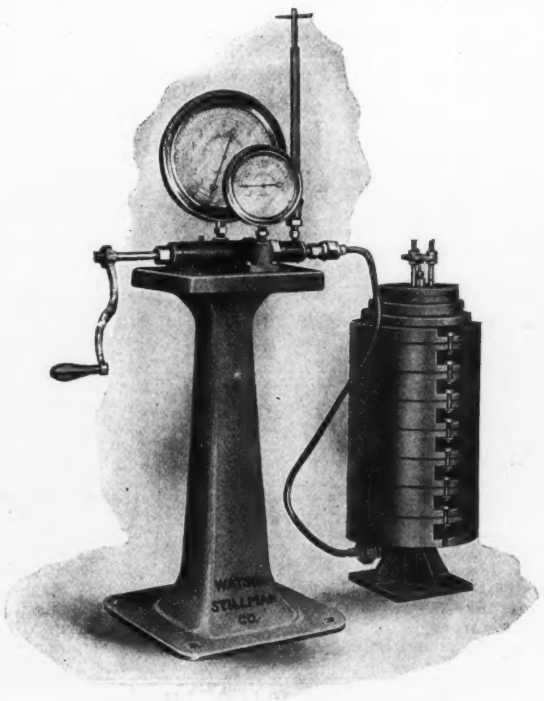
WHILE THE INTERNATIONAL ACHESON GRAPHITE CO. of Niagara Falls may always be expected to be in position to meet the extended and varied requirements of old and new customers in all parts of the world, it is nice to point out how it met a recent test of its remarkable facilities and demonstrated the fact that it was not found wanting. Between 1 and 2 o'clock on the afternoon of Friday, July 2, a telegraphic order, calling for the shipment of a carload of electrodes 8 by 48 in. by express was received. The works and an express company were immediately notified.

At 5 p. m. an express car was delivered on the track in front of the products building. At 5:30 p. m. a locomotive on the Niagara Junction Railroad was pulling away with the loaded car for delivery to the Michigan Central R. R. It left Niagara Falls about 6 p. m., Buffalo about 8 p. m., and very early on Saturday morning the electrodes were deliverd to the consignee in Chicago, Ill. The regular shipments of the day were not interrupted, there was no overtime, and the consignees were made happy by the prompt shipment.

The value of the service to the consumer is more apparent when it is known that, if the business judgment of the Acheson Graphite Co. had not been such as to have these very large electrodes in stock, a delay of from 10 to 12 weeks would have resulted. Regular

and prospective customers should always anticipate their wants as much as possible, for, ordinarily, the time period specified is consumed in getting the carbons and graphiting them.

WATSON-STILLMAN CO. of New York has a new calibrating apparatus for high pressure gages which may be used either for comparison with a mas-



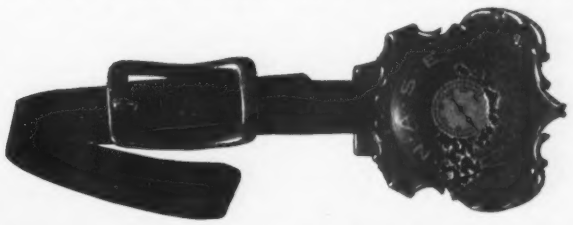
ter gage or for testing the master gage against dead weights. The design is as shown herewith.

GOLD MEDAL has been awarded by the Alaska-Yukon-Pacific Exposition to the Ferro gas engine for a 2-cycle engine; also, silver medal as second prize for heavy duty engines. This is the first time that a 2-cycle engine has received a prize for heavy duty and is noteworthy on that account.

THE DODGE MANUFACTURING CO. is in the midst of plant extension work of the factory at Mishawaka, Ind. The main or south machine shop is being enlarged by the erection of a large addition which when ready for occupancy, will be a complete building itself. The addition is 280 ft. long and 122 ft. wide, like the older portions of the shop, but the side bays will be higher to accommodate a second floor or gallery. The framework of the structure is of steel, the supporting columns resting on concrete foundations. A cream brick is being used for the walls with metal sashes. Light and ventilation are always big items in the Dodge buildings and the new one will contain 158 windows and 2 good-sized doorways.

When the old shop is thrown into that under construction, the total length will be 585 ft. on the crane runway in the center bay. Two electric traveling cranes—25 tons and 10 tons, respectively—will serve the main middle bay, where all machines are placed and where all heavy work is done. In the side bays several lighter electric cranes will handle the smaller work. The traveling cranes are of the Whiting and Niles types. They have a speed of 300 ft. a minute, and much time and labor is saved by their use in moving heavy products and placing them in cars which are brought directly into the plant for this purpose. The top floor will be devoted to the production of Dodge split friction clutches, this department of the Dodge works being overcrowded by the continued growth of the business, even though at this time it covers a space of more than 12,000 sq. ft. Elevators will be used between the 2 floors for transportation.

THAT WAS A MIGHTY ATTRACTIVE WATCH FOB that the Pilley Packing and Flue Brush Co., distributed at the recent Columbus Convention, and those who were fortunate enough to get one have been exceedingly proud of it. The company announces that it has a few of these left and to those who send in first will come the good fortune to have one of these handsome fobs to wear for the com-



ing year. A letter to the Pilley Packing and Flue Brush Co., St. Louis, Mo., mentioning the Practical Engineer will bring one of these fobs by mail, to those who apply in season.

AS EVIDENCE OF the complete satisfaction that Angle Compound high-speed engines are giving, the American Engine Co. of Bound Brook, N. J., reports orders for 20 500-hp. Angle Compound engines to be used for running centrifugal pumps of the Interborough Rapid Transit Co. power plants, as a result of the good performance of similar engines installed earlier in the season.

THE GENERAL ELECTRIC CO. has just listed a new 100 to 125 volt tungsten lamp. It is rated at 150 watts and supplied in 3 3/8-in. pear-shaped bulb. The lamp is designed to supply an intermediate unit between the 100 watt and the 250 watt types. It has all the well-known and superior characteristics of the G. E. tungsten lamp, the same method of mounting and the special anchoring support for the filament which insures a maximum of mechanical strength and ability to withstand usage and permitting its satisfactory operation in any position.

THE GOVERNMENT HAS RECENTLY placed an order with the Foos Gas Engine Co., of Springfield, Ohio, for 6 of their vertical engines to be used in the operation of locks on the Ohio River. The locks are operated by air, the 4 engines for driving the compressor being of 100 hp. each, and the smaller ones used for auxiliary apparatus. The engines specified are the regular Foos vertical 3-cylinder single acting engines, using natural gas for fuel. The power requirements will be exacting, and the reliability of the engines installed must be beyond question.

THE BEST ENDORSEMENT of a good thing is that from a user who knows. From John C. Stier, chief engineer of the Mason City, Iowa, Water Works, comes a letter in regard to the Mabbs Rawhide Packing, which tells its own story. It was addressed to the Mabbs Hydraulic Packing Co., of Chicago.

"I enclose you in separate package to-day a sample of your packing which has been in constant use for 6 yr. and to my knowledge there have not been over 3 or 4 rings added during that time. The rods are in

excellent shape and do not show any wear whatever. This pump has been running 365 days in the year, only shutting down long enough to pack steam end or water plungers. I had no business to remove packing when I did, only through curiosity, as it was doing excellent work at time of removal. I consider it the finest cold water packing on the market to-day. It being antifrictional, its durability and lasting cannot be excelled. I send you this unsolicited, for I believe when anything is good to praise it for what it is worth."

YORK MFG. CO. has made the following sales since last March: Allegheny County Workhouse, Allegheny, Pa., 1 10-ton refrigerating plant; Sibley, Lindsay & Curr Co., Rochester, N. Y., 1 40-ton refrigerating plant; Lancaster Ice & Cold Storage Co., Lancaster, S. C., 1 10-ton ice making plant; United Fruit Co., Port Antonio, Jamaica, W. I., 1 25-ton ice making plant; United Dairy Co., Wheeling, W. Va., 1 10-ton refrigerating plant; H. L. Neuman, York, Pa., 1 10-ton refrigerating plant; Bernards Water Co., Bernardsville, N. J., 1 10-ton ice making plant; San Antonio Machine & Supply Co., San Antonio, Texas, 1 10-ton refrigerating plant for David Pryor, Uvalde, Texas; Ambridge-Economy Brewing Co., Economy, Pa. 1 30-ton compression side; G. N. Ladley, Philadelphia, Pa., 1 6-ton refrigerating plant; Belle Springs Creamery Co., Salina, Kans., 1 8-ton refrigerating plant; Bell Apartment House, Montgomery, Ala., 1 6-ton refrigerating plant; John Bouchard & Sons Co., Nashville, Tenn., 1 8-ton refrigerating plant; Stevens & Hay, Pottsville, Pa., 1 25-ton ice making plant; Charles H. Helmers, Jersey City, N. J., 1 4-ton refrigerating plant; Lovegrove & Co., Inc., 1 2-ton refrigerating plant; J. F. Zeinfuss, Philadelphia, Pa., 1 2-ton refrigerating plant; W. J. Mehring, Harrisburg Pa., 1 8-ton refrigerating plant; Greenway Brewery, Syracuse, N. Y., 1 8-ton refrigerating plant; Ashland Pure Ice Co., Ashland, Pa., 1 15-ton ice making plant; Cremo Brewing Co., New Britain, Conn., 1 30-ton ice making plant; Puritan Hotel, Boston, Mass., 1 8-ton refrigerating plant.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rate of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—By a man, 26 years old, with 3 years' experience with machinery. Good references as to honesty, sobriety and ability. Harry Kelley, R. R. 39, Prattville, Mich. 11-2

AS ENGINEER—By experienced steam-electric engineer holding Montana first-class license. Experienced with high speed and Corliss engines, and boilers of all types; 10 years' experience. Address Box 120, Practical Engineer. 12-2

POSITION—Young man, 21 years old, wants position as assistant engineer or helper. About half through with an I. C. S. course in Mechanical Engineering. Also a Band man. Strictly temperance. For further information address Henry Herbert Carter, Box 271, Vulcan, Mich. 11-2

ENGINEER AND ELECTRICIAN to take charge of your power plant. Experienced in rope and electrical transmission of power. Well up in modern appliances for economical power production. How is your plant, Mr. Owner—bad? Want better results? Let me hear from you. Want to change to western town. Address Box 21, Practical Engineer. 12-2

POSITION WANTED—As assistant engineer. Seven years' experience, also nearly completed course in I. C. S. Can furnish good references. Address F. F. Ninman, Belle Plaine, Wis. 12-2

Help Wanted

NICE SIDE LINE for steam specialty salesmen. Reiter Boiler Cleaner Co., Elgin, Ill. 9-tf

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 15 of this issue. 9-tf

WANTED—An experienced turbine engineer to take charge of a new turbine electric power station now being erected. Give experience and reference; also state salary desired. Address Box 122, Practical Engineer. 12-2

ENGINEERS AND MECHANICS—**To make big money selling Incomparable "1-2-Z" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass.** 4-tf

For Sale

FOR SALE—All kinds of high grade rebuilt engines, boilers, etc. See list in display advertisement in another part of this issue. The Randle Machinery Co., 1767 Powers St., Cincinnati, O. 10-tf

FOR SALE—60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago.

Machinery For Sale.

FOR SALE—ENGINES AND BOILERS—Corliss—Heavy Duty, 18 x 36 Ohio, 24 x 30 Clark, 22 x 48 Allis. Girder Frame, 14 x 30 Bass, 18 x 42 Allis, 22 x 42 Hamilton, 28 x 54 Hamilton. Automatic—All sizes, 30 to 400 hp. Send for list. Throttling engines from 10 to 100 hp. Woodworking machinery of all kinds. Cleveland Belting & Machinery Co., 1922 Scranton road, Cleveland, Ohio. 9-tf

Patents and Patent Attorneys

PATENTS AND PATENT ATTORNEYS

PATENTS—Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4-tf

PATENTS—For a Canadian or foreign patent send sketch for free report. Patentability certificate given. Canadian patents taken up for sale if desired. Send ten cents for booklet and inventors' monthly magazine. Ben. B. Pannett, Ottawa, Ontario, near Patent Office. 9-tf

THE INVENTORS' UNIVERSAL EDUCATOR tells all about patents and how to secure them. Has 600 mechanical movements, also 50 perpetual motions. Every inventor should have a copy. Price $1.00 by mail. Address F. G. Dieterich, Oray Bldg., Washington, D. C. 9a10-tf

PATENTS—C. L. Parker, late Examiner, U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

ENGINEERS—Pack your Corliss valve rods with Ideal Metallic Packing. Three years' guarantee. Price per inch diameter of rod $1.00. Ideal Metallic Packing Co., South Stillwater, Minn. 8-tf

FREE, ANY FIRM owning a steam plant, or any engineer in charge of steam plant, that is troubled with scale and has to use boiler compound can get the best indicator and reducing wheel made, free. Address Great Lakes Chemical Co., Manitowoc, Wis. 10-tf

ORANGES, GRAPEFRUIT, TANGERINES as Christmas presents for your friends. Either mixed boxes, or one kind in box shipped to any address on receipt of price, cash with orders. All orders must be in 2 weeks before Christmas. Nothing less than box shipped. Oranges, per box, $1.65; grapefruit, per box, $3.00; mixed fruit, per box, $1.75; tangerines, per strap, $2.00. All fruit picked same day shipped and guaranteed to be first class. Address M. M. Shellaberger, R. No. 1, Bartow, Fla. 11-2

Cobb's High Pressure Spiral Piston Rod and Valve Stem Packing

Cobb's Throttle Packing

Cobb's High Pressure Ring Packing

Graphon Spiral Packing

THESE illustrations show a few of our standard, high grade, Spiral, Ring and Sheet Packings, which we manufacture for use in Locomotives, Steamships, Paper Mills, Saw Mills, Mines, and Mill Engines of all kinds.

We have doubled the capacity of our Packing Department at the Factory, and are equipped to make Packings to meet any condition at short notice. Write for samples and Engineers' Catalogue, showing our full line.

Magic Diagonal

Indestructible White Sheet Packing

Karbonite Black Sheet Packing

Ruby Red Sheet Packing

Branches
CHICAGO, ILL. 150 Lake St.
ST. LOUIS, MO. 218-220 Chestnut St.
PHILADELPHIA, PA. 118-120 North 8th St.
SAN FRANCISCO, CAL. 129-131 First St.
BOSTON, MASS. 232 Summer St.

NEW YORK BELTING & PACKING COMPANY, LTD.

91-93 CHAMBERS STREET, NEW YORK

Branches
PORTLAND, ORE. 40 First St.
PITTSBURGH, PA. 913-915 Liberty Ave.
SPOKANE, WASH. 163 S. Lincoln St.
INDIANAPOLIS, IND. 229 S. Meridian St.

MARCO MARCO MARCO MARCO MARCO MARCO MARCO MARCO
PACKING PACKING PACKING PACKING PACKING PACKING PACKING

THERE are all kinds of valve stems, globe valve stems, throttle valve stems, engine valve stems and Corliss valve stems. An engine valve stem often requires a better packing than the piston rod. The temperature inside the steam chest is always that of live steam at boiler pressure. The temperature inside the cylinder is on the average far below that, so the stuffing box of the piston rod is considerably lower in temperature than the valve stem stuffing box. Otherwise the proposition is the same. On general principles it is best to use an asbestos packing on a valve stem. Certainly if the pressure is over 125 lbs. A valve stem doesn't have so much travel as the piston rod and it doesn't have so great a cooling effect of the rod. As it is a warmer proposition, it's best to use asbestos.

Corliss admission valve stems are an even hotter proposition. The rod can't cool the packing in this case. It's best when packing a Corliss valve stem to use asbestos entirely, or to have an asbestos ring in the bottom of the box. This protects the rest of the packing. A packing should be used that grips the rod as lightly as possible and yet pack steam so as to avoid wearing grooves around the rod. Corliss release valve stems can be packed with any good packing. A throttle valve should be packed with an asbestos packing that has nothing in it that can stick the valve so that it'll not work easily. An ordinary globe valve can be packed with a good many different things, but here again it's better to use an asbestos packing.

MARCO packings are made for every class of service. We hvae packings for every kind of valve stems. Our asbestos packings are made of the very best asbestos obtainable. We'll be glad to have you burn them and prove to yourself that they're firstclass in every way. They have a special lubricant which gives the least friction and can't affect the materials used. Drop a line today and get a catalog, from which you can pick the styles of packing which will suit your needs.

So long,

M. ARGO.

L2

THE CLEVELAND RUBBER WORKS
OF THE MECHANICAL RUBBER CO.,
74 LISBON ROAD,
CLEVELAND, OHIO.

MARCO MARCO MARCO MARCO MARCO MARCO MARCO MARCO
PACKING PACKING PACKING PACKING PACKING PACKING PACKING

WE GOT THERE FIRST!!

THERE IS NO DISPUTE AS TO WHO DISCOVERED

RAINBOW PACKING

THE SECRET OF ITS MANUFACTURE IS KNOWN TO US ONLY, AND IMITATORS NEVER HAVE AND NEVER WILL SUCCEED IN FINDING IT. THE VALUE OF OUR DISCOVERY HAS BEEN APPRECIATED BY ENGINEERS THROUGHOUT THE WORLD AS IT HAS SAVED THEM LOTS OF HARD WORK AND THEIR EMPLOYERS LOTS OF MONEY.

MANUFACTURED SOLELY BY

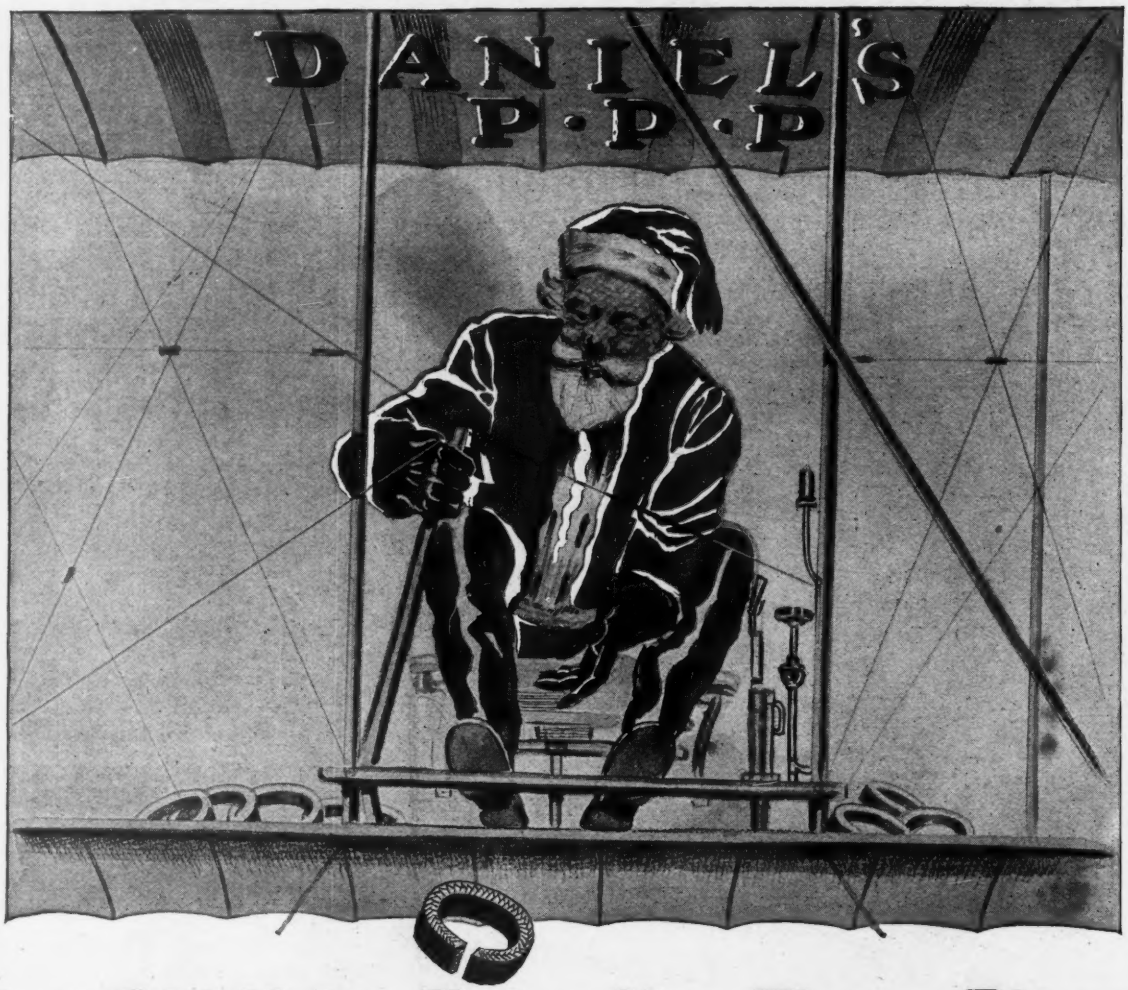
THE PEERLESS RUBBER MANUFACTURING COMPANY

16 WARREN ST., NEW YORK

DETROIT, MICH.—16-24 WOODWARD AVE.
CHICAGO, ILL.—202-210 SO. WATER ST.
PITTSBURG, PA.—425-427 FIRST AVE.
SAN FRANCISCO, CAL.—416-424 MISSION ST.
NEW ORLEANS, LA.—COR. COMMON & TCHOUPITOULAS STS.
ATLANTA, GA.—7-9 SOUTH BROAD ST.
KANSAS CITY, MO.—1221-1223 UNION AVE.
SEATTLE, WASH.—212-216 JACKSON STREET
LOUISEVILLE, KY.—111-121 W. MAIN ST.
INDIANAPOLIS, IND.—38-42 SO. CAPITOL AVE.
OMAHA, NEB.—1218 FARNAM ST.
DENVER, COL.—1556 WAZEE STREET
RICHMOND, VA.—1323 E. MAIN STREET
WACO, TEXAS—709-711 AUSTIN AVE.
BOSTON, MASS.—110 FEDERAL ST.
BUFFALO, 379-383 WASHINGTON ST.
MILWAUKEE, WIS. 96-100 SECOND ST.
SYRACUSE, N.Y.—212-214 SO. CLINTON ST.
LOS ANGELES, CAL.—115 SO. LOS ANGELES ST.
PORTLAND, ORE.—14-16 FIRST ST.
BALTIMORE, MD.—37 HOPKINS PLACE.

FOREIGN DEPOTS

LONDON E.C., ENGLAND.—11 QUEEN VICTORIA ST.
PARIS FRANCE.—76 AVE DE LA REPUBLIQUE.
SYDNEY, AUSTRALIA.—270 GEORGE ST.
JOHANNESBURG, SOUTH AFRICA.—BARSDORF B'L'D'G.
COPENHAGEN, DEN.—FREDERIKSHOLMS KANAL 6.
VANCOUVER, B.C.—CARRAL & ALEXANDER STS.



Let Old Kriss Bring You Three Rings of Daniel's P. P. P. Rod Packing

Kriss is up-to-date; he now uses an AEROPLANE instead of reindeers and sleigh for delivery purposes. In his factory he has discarded the old-style "solid" rod packings, and uses none but the genuine

Daniel's P. P. P. Rod Packing

the first and only "sliding wedge" packing constructed on truly scientific principles, and the only kind that can last any length of time.

FREE XMAS GIFT

If you want to profit by the Old Man's experience, write to him, in care of us. He will tell you how to try P. P. P., at our risk, also how to get a valuable Engineering Hand Book as a Christmas present.

Use a postal card and say

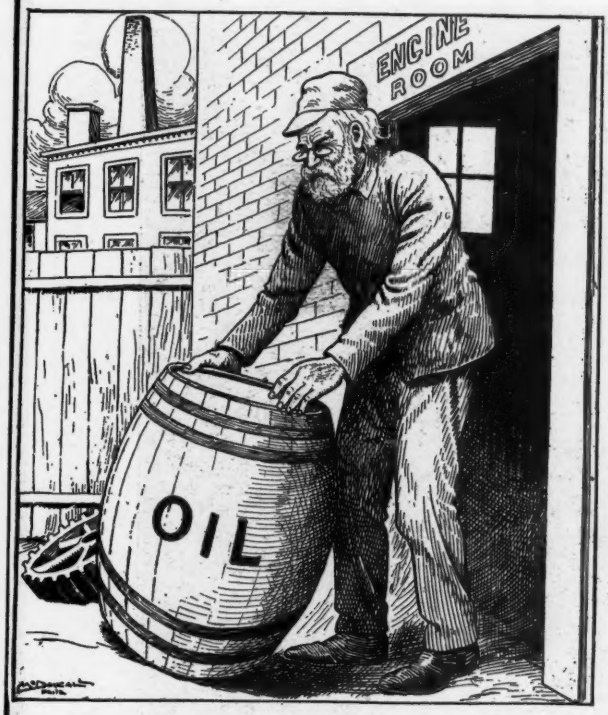
"How can I get the FREE Book, 11-L?"

QUAKER CITY RUBBER COMPANY

Philadelphia : : : Chicago : : : Pittsburg

KEYSTONE FABLES NO. 7

THE TALE OF THE AGED ENGINEER



Once there was an old Engineer who had spent his Time watching one Engine ever since the first Time that Belva Lockwood ran for President.

He knew his Engine like a Book. His quick Ear detected, as if by Magic, when the least Thing went on the Blink and he was ever on the Job—as spry and active as a July Cricket.

Nevertheless, because he didn't conceal his Age by Dyeing his Hair and Marrying a Second Time the Boss began to Dope it out that a Younger Man might Help Some in the Business.

Just about the Time when the Boss began to look in the Want Ads for a Good Man, the Aged but Wise Engineer began to Get Busy. Lubrication Bills, Repair Bills, and all the other Expenses of a big Power Plant were cut about one-half in a Month and the Boss, who hadn't been in the Engine Room for Fifteen Years, Sat Up and Took Notice, for this had never Happened before. He could not Figure Out what had Put Him so far to the Good and at last he decided to Investigate.

As the Bookkeeper couldn't give Reasons and the Foreman was in the Dark he finally Brought up in the Engine Room where he got Wise in Four Minutes. The Ancient One, in a few Choice Words, showed him that for Years he had been Losing Money because he used Oil instead of Keystone Grease, the natural Money Saver. He learned with Amazement that Keystone Grease never Melts nor Hardens, no matter what the Temperature, never Gums, and that One Pound of Keystone Grease outdoes and outlasts Four Gallons of any known Oil. He was shown how his Insurance Bills were going to be Cut and where he had saved Good Money in gaining Fifty Per Cent in Power, Cleanliness, and Time. All this had Happened because the Old Engineer had ordered a Sample Barrel of Keystone Grease and Tried it on The Works.

The Old Man is still on the Job and you can't Lose Him. If You Want to Make Good send for a Sample Barrel and be in the Push. It Pays.

Cut out the coupon below, mail it, and make a test of

KEYSTONE GREASE

Cut out the Coupon below and mail it to

KEYSTONE LUBRICATING CO. - - - PHILADELPHIA, PA.

Main New England Office & Warehouse—10 Oliver St., Boston, Mass.
Northwestern Agency & Warehouse—502 McPhee Bldg., Denver, Colo.
Main Southern Office & Warehouse—610 Chartres St., New Orleans, La.

Main Pacific Coast Office & Warehouse—268 Market St., San Francisco, Cal.
Western Office & Warehouse—Tacoma Bldg., Chicago.
New York Office & Warehouse—96 Warren St.

ORDER AND AGREEMENT FORM

Dept. F.

Date.....

THE KEYSTONE LUBRICATING CO., Philadelphia, Pa.

Please ship us one barrel KEYSTONE GREASE, on ninety days' time from date of shipment. If results prove unsatisfactory the unused portion to be returned and no charge to us made for the quantity used.
Eight brass grease cups to be sent free of charge with first barrel bought.

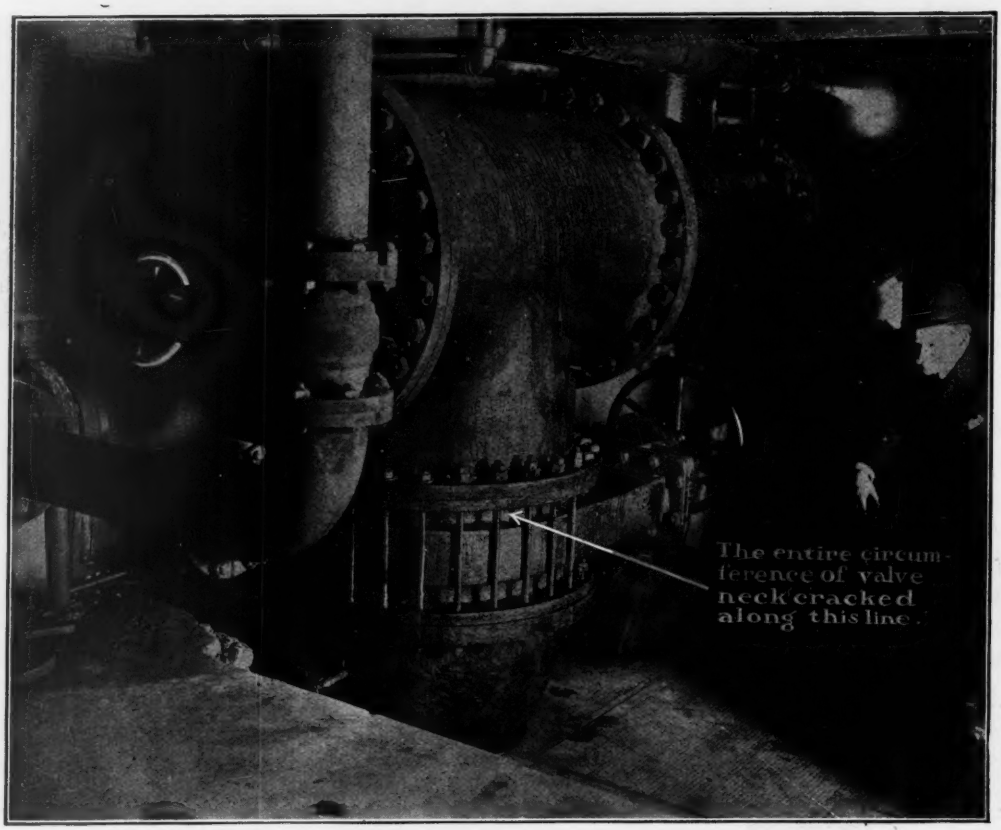
Signed.....Per.....

Town.....State.....

SMOOTH-ON

TRADE MARK

(Trade Mark Registered U. S. Patent Office.)



The Permanent Repairing Agent

Here is One SMOOTH-ON Performance

SOUTH SIDE ELEVATED R. R. CO.,
POWER HOUSE 40TH AND STATE STS.,
CHICAGO, ILL., APRIL 10, 1908.

SMOOTH-ON MFG. CO., JERSEY CITY, N. J.

GENTLEMEN:

This photograph was taken from a 30-inch Gate Valve which is in the 30-inch suction line for the Condensers. This valve cracked all around under the top flange. I cleaned the crack, filled it with ***Smooth-On Iron Cement No. 1,*** put the rods across as shown in photo, and drew it together. This was done about two years ago, and it has been as good as new ever since.

SMOOTH-ON is a very useful article in a power plant and I would not think of being without it.

Yours very truly,
(Signed) A. L. HADEN, CHIEF ENGINEER.

Sold in Blue Label Cans for cold work; Gray Label for hot work. ***Send for free Instruction Book.***

Smooth-On Manufacturing Co.,

572-574 Communipaw Ave., Jersey City, N. J., U. S. A.

Chicago Warehouse, 231 N. Jefferson St. San Francisco Warehouse, 20 Sacramento St.

English Branch, 8 White St., Moorfields, London, E. C

Time tells the tale

and it has told it well in the life of **Eureka Packing.** For more than 25 years **Eureka** has been the standand packing, with the thinking engineer. A few of the "reasons why" are:—the correct construction, superior materials used, the excellent work it does, the long-lasting efficiency, the slight friction it creates, the increased power it enables the engine and pump to develop, the absence of rod wear and the moderate price at which it is sold.

There good qualites combined make it the very best for both good and bad Engines and Pump rods, Thousands of engineers whose Engine and Pump rods are scored or out of line give thanks to **Eureka** for help that could not be found in any other packing. No other good packing is built on the same lines of honesty in material and manner of putting together—and no other will give such satisfactory results. We hope this little **Eureka** tale may interest you enough to try **Eureka**—be sure to name **Genuine Eureka.**

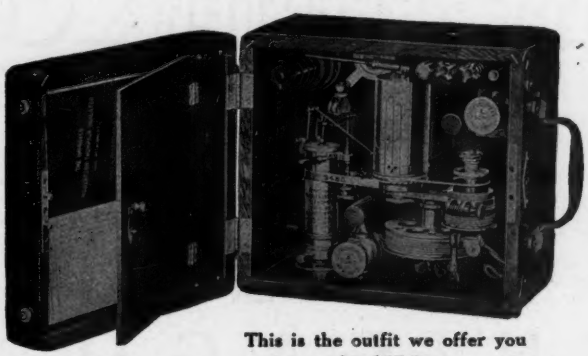
Eureka Water Proof Hydraulic fills a long felt want for a packing for all cold water purposes. Long line flax, well braided and water proofed in a superior manner, gives a service not to be found in any other make. Specify **Eureka Water Proof** and get the best. Finished in coil spiral and ring form.

Get our handsome Catalog of 37 varieteis and then order by number.

EUREKA PACKING COMPANY

JAS. L. ROBERTSON, President

Sales Department, 74-76 Murray Street, New York



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The Silent, Thougthful Engineer

is the one who makes the most out of every opportunity offered. He sees in the indicator, and knowledge of its use, one of the surest paths to progress in his profession, Many hundreds of the most thoughtful Engineers have purchased the Robertson-Thompson Indicator and Victor Reducing Wheel, which are offered at $45, $10 down and $5 a month, or 10% off cash with order.

The outfit is yours after the first payment — we take no mortgage, simply satisfactory references. Guaranteed in construction, accuracy and durability.

The Willis Planimeter, price $12.50, is also offered with 10% discount for cash. Write for further details.

JAS. L. ROBERTSON & SONS
74-76 Murray St., NEW YORK

We've Removed from E. 149th St., New York To New Brunswick, N. J.

because "it is cheaper to move than pay rent" in a place that's too small for us.

We've "moved" because our business is moving—because so many people are finding out how good our stuff is—and buying—and *then* buying—that we just simply had to have more room.

So we're *out in* "Jersey," about an hour *out—out* for more business because we're *in* shape to take better care of it. We're *out* to *make* money by *saving* money *in* every power plant that wants to put *in* flange gaskets, but that will *stay in* indefinitely, *in*stead of those that blow *out* every few days or weeks.

Goetze's corrugated metal-gasket with asbestos No 2
Goetze's patent double copper gasket with asbestos lining section V.

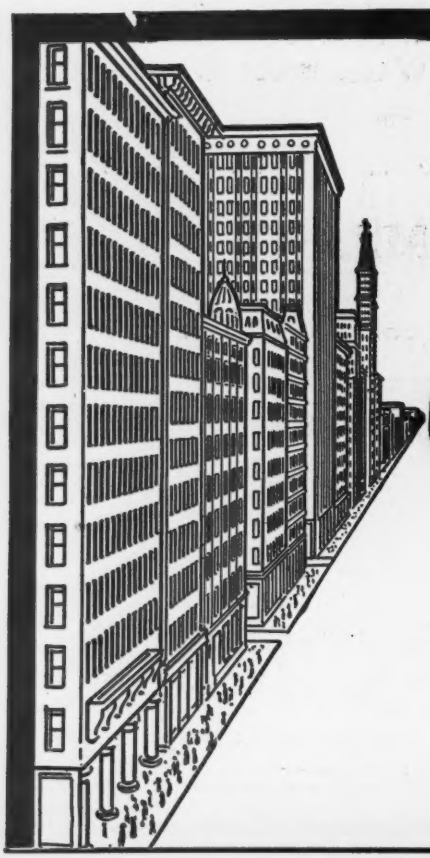
Come *out* and see us. Like Goetze's Gasket you'll find us *in* and working. But you don't have to come *in* to find *out* about Goetze's Elastic Copper. Corrugated Gaskets and Elastic Copper Valve Disks. You don't even have to ask your neighbors or believe the yards of testimonials we print. Just write and say you'd like a try-*out* without a blow *out, in* your own plant, and we'll *show* you. If we don't, it's up to us. If we do, it's up to you—to save money, time and trouble.

Ask for "Circular Two," "Valve Disk Talk"—or both.

American Goetze-Gasket & Packing Company

New Brunswick, New Jersey

where we had to remove from East 149th Street, New York, to take proper care of our growing business



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Made Without Laminations

The Original Heat-Resisting Fibre Sheet Packing will Hold 350 Lbs. Steam Pressure, no Following up of Joints Necessary.

Guaranteed for Saturated or Superheated Steam under Highest Temperature. Also Air, Hot Water, Ammonia, Acids, Oils.

Beware of Imitations.

Genuine has VANDA Trade Mark Stamped on every Sheet

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Rosy cheeks and sparkling eyes
Result of healthy exercise,
Bringing home the Christmas tree
Just as happy as can be.

For there's no more work for Dad at night.
Now his engine works alright,
He says Black Squadron "Is out of sight"
For keeping valves and pistons tight.

You fill in this coupon below and we will send you a free ring of the best packing you ever saw.

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Gentlemen:—Kindly send ring of Black Squadron Packing
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H. P. of engines.....Employed by.....
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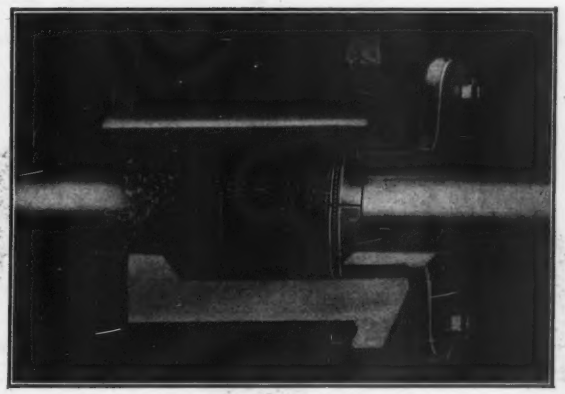
"PALMETTO"
REG. TRADE MARK
PACKING



Don't push the Packing through an Open Gland,

(*too Large an Opening around the rod*) the bevel ends of the stuffing box only increases the difficulty when you set up on the follower nuts.

Put a Split Babbitt Metal Ring

in both ends of the box to hold the PALMETTO packing against the rod and give it long life and efficiency. We will furnish these metal rings at low cost.

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Standard LEATHER PACKINGS

In All Sizes

For All Purposes

Hundreds of manufacturers, both in the United States and Canada, have adopted Standard Leather Packings. They *know* how good they are because they've *used* them.

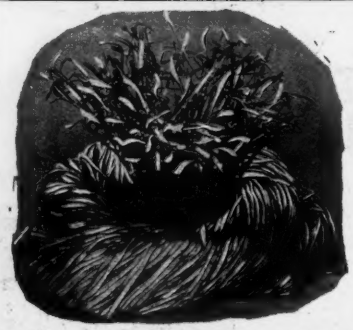
Somewhere, every hour of every day, Standard packings are doing the work required of them in a most satisfactory way.

See what they will do for *you*.

Our catalog is free.

KENDRICK VALVE & WASHER CO., 316 East Water St., SYRACUSE, N. Y.

Distributing Agent: Geo. P. May, Peoples Savings Bank Bldg., Pittsburg.



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The Original Lubricated Metallic Fibre

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A Patented, Plaited, Fibrous Packing, suitable for high pressures. Far superior to any other hydraulic, fibrous packing on the market.

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WEARWELL LEATHER PACKINGS

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Best leather, prompt service, and many years of experience make Wear Well Leather Packings the most serviceable and profitable Packings. They are made to your specifications, they fit perfectly, and give satisfactory wear.

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is so easy to put on, you will be pleased with it from the first. By simply putting on the rings, slipping up the lower half of the metallic case and then after the top half is in place, tightening up the four countersunk machine screws that hold it together, your packing troubles are ended.

One of our 12,000 satisfied users is in your neighborhood. Average life of 8,000 France Packings is seven years; some as long as ten and twelve years.

Thirty days trial. Three years guarantee

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Do you know to what extent your fuel or power expense is increased by the viscosity of the grease you are using? How much drag is there on your power to overcome it? These should be live questions with you.

In making the Acheson-Graphited Greases we are enabled to use a grease of much less viscosity than is found in plain, ordinary greases, as the Unctuous, Soft, Pure Graphite affords body while being a Perfect Lubricant in itself. There is a very pronounced advantage in this. The graphite is practically pure. You cannot get it in any other grease. You cannot buy another grease that possesses the Endurance, Efficiency and Economy found in our Graphited Greases.

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We Are the Only Makers of Graphite in the World.

"SAFETY" PLASTIC METALLIC PACKING

For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.

Guaranteed to stand Steam Temperature up to 550° F. and Hydraulic Pressure to 5000 lbs. per square inch.

Highest Award Worlds Fair, St. Louis.

Send for **FREE SAMPLE** and particulars.

MANUFACTURED BY
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Ambest
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The Packing That's Always Ready for Use.

No trouble to pack the smallest valve or the largest rod. It's all done from the same can.

No rods to measure or gland dimensions to be given, therefore no mistakes. It always fits.

No sizes to carry for your different rods or valves, therefore you save time and trouble, and the satisfaction you derive in using "AMBEST" will make you send for more.

If you will give us your name and address we will send you a free sample, prepaid.

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Quality, not Price the Inducement
A sample will interest—a trial convince.

Booklet Describing our Entire Line on Request.

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One of the Largest Gun Boats in the World, the North Dakota, is Equipped with

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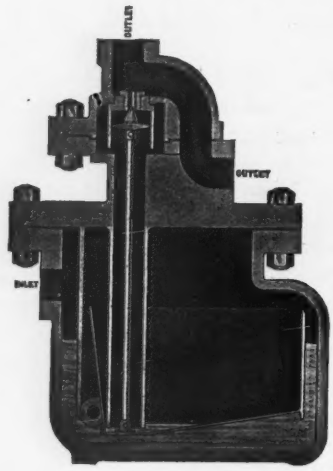

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Why?

Because actual tests proved that the STRONG TRAPS are made of the highest grade of material, that they have a big capacity, and close absolutely tight, making it impossible for steam to escape.

Because they are easy to inspect, particularly the only wearing parts, the valve and seat.

Let us send you our Catalog E-20.

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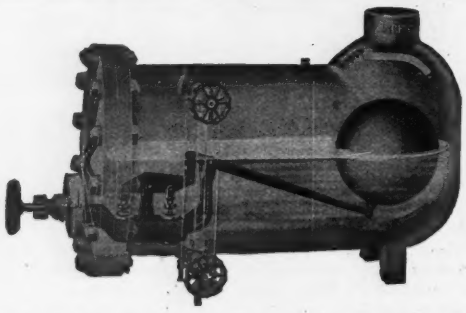


The vital parts of a steam trap are the valves and seats. These parts are subject to the greatest wear and are generally the cause of most trap troubles.

A trap with leaky valves is an absolute expense, for it not only fails to perform its service, but allows valuable steam to escape.

The Davis Improved Steam Trap

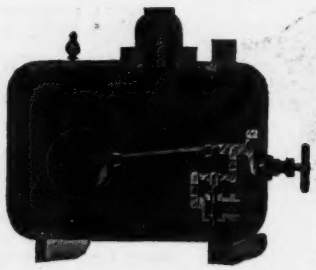
has renewable valves and seats made of Tobin Bronze—a non-corrosive metal that is practically as hard as steel. It will resist the cutting action of water and the grit that may come with it, many times longer than can the best steam metal which is almost universally used for this purpose. Send for new descriptive booklet.

Your supply house should have Davis Traps in stock —if not, we have.

G. M. DAVIS REGULATOR CO., 427 Milwaukee Ave., CHICAGO

Manufacturers of

Davis Pressure Regulators, Exhaust Relief Valves, Stop and Check Valves, Back Pressure Valves and other Specialties.



"Eclipse" Steam Trap

A balance valve makes it adaptable for high or low pressure. A strainer attachment keeps out all scale or sediment. Working parts are attached to the cover, which may easily be removed. Best of materials, every trap tested.

Write for sizes and prices.

This is but one of the many high class John Davis "Eclipse" Steam Specialties owned and manufactured by the

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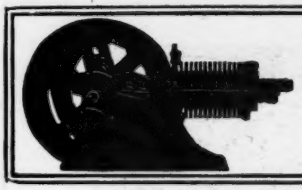

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$60 GILSON Gasolene ENGINE

For Pumping Cream Separators, Churns, Wash Machines, etc. FREE TRIAL. Ask for Catalog—all sizes.

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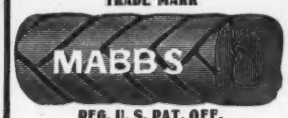

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MABBS RAWHIDE PACKING

THE PACKING for Water Works, Mine Pumps, Air Drills, Ice Machines, and all machinery using cold liquids.

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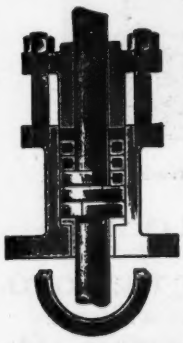

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The Packing that Lubricates

250,000 SETS IN USE.

You can use the different types of HUHN Metallic Packing for *any* purpose—steam, water, air, gas, ammonia, oil, varnish, brine—anywhere packing is needed.

Supplies its own lubricant and wears so long you'll forget it is working.

We'll send you a booklet if you'll say where.

AMERICAN HUHN METALLIC PACKING CO.
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This Will Interest You

Burgmann's Self Lubricating Engine Packings for High Speed and High or Low Pressure work are known the world over as the best and most economical to use.

Burgmann's Hydraulic Packing (lubricated) for high duty work cannot be equalled for its general efficiency.

Burgmann's Pump Packing (lubricated) for hot or cold water is just what you want—you can rely upon it.

All of the above are expansion packings, free from rubber; soft, pliable, light in weight and cannot score or bind your rods. **Write for Catalogue.**

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Nason Steam Traps

"CLASS B" "CLASS C" "SIDELUG"

"Class B"

"Class B" Traps

are designed for low pressure conditions, where the pressure is not higher than 20 lbs. nor lower than 1 lb. Its construction embodies the "Nason" principle in every detail.

"Class C"

"Class C" Traps

are designed for ordinary conditions where the pressure is not higher than 70 lbs. nor lower than 20 lbs. It is identical with the "Class B," except in valve area.

"Sidelug"

"Sidelug" Traps

Patented

are designed for high pressure conditions to 150 lbs., with a low pressure range to 40 lbs. This trap is extra heavy and cover is reinforced over ports with extension lugs, preventing blowing out of gaskets.

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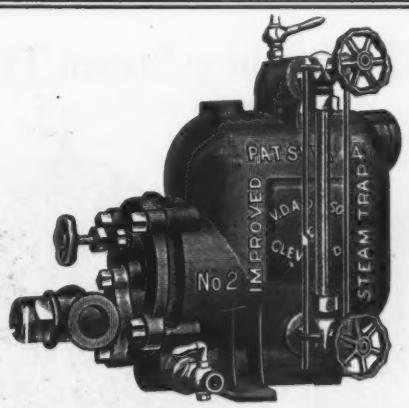

Get Anderson Traps

For Any Pressure

Our Standard Trap will work at any pressure from 150 pounds down; but for low pressure service we can furnish the trap with extra large valve outlet, which takes care of all condensation perfectly.

In ordering tell us for what pressure.

Shall we send a booklet?

THE V. D. ANDERSON COMPANY
1937 West 96th St., Cleveland, Ohio

OUR CLAIM

It is only the **Interlocking** Tubing which will stand High Pressure *under service* and will bend constantly without any resulting harm. Its **Interlocking** feature makes it the *only* succesful metal hose in existence. Used all over for all liquids, air, steam, oils, gases ammonia, etc.

All Sizes, from ⅛" to 12". Write!

Pennsylvania Flexible Metallic Tubing Co.

Manufacturers of Flexible Metallic Tubing and Hose

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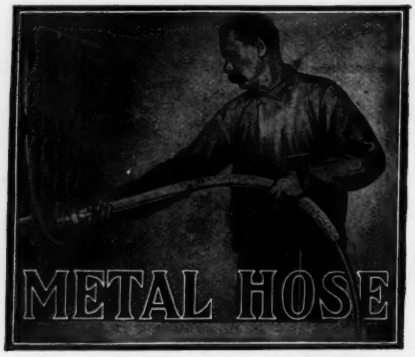
METAL HOSE

A practically indestructible substitute for rubber hose. Admirably adapted for blowing boiler flues, high pressure steam, oils, gas, suction purposes, etc. Contains no rubber.

Made in sizes from 5-32 to 12 inches in diameter. Ask for prices on ¾ inch in copper, any length.



Used by Navies of the World

ASK FOR INTERLOCKED

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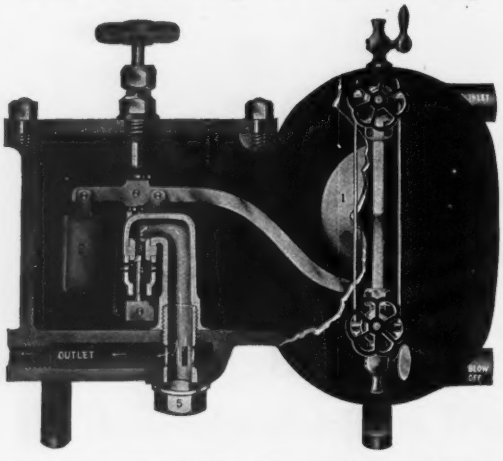
63-65 Main Street SAN FRANCISCO, CAL.

The Sterling Steam Trap



A quick, removable mechanism, without breaking pipe connections, works at any pressure and is equipped with Sterling Indestructible Float.

The combination of balanced float and vertical valve overcomes the friction found in all other float traps, and the result is greater discharge capacity and elimination of wire drawing in valve.

Counter balance float (1) operates vertical valve (4) hung on rods from float lever; by unscrewing nut (5) the whole internal mechanism can be lifted out.

The Sterling is the only and original trap wherein you do not have to break any pipe connections to get all the parts out of the casing. Overhauling a trap formerly required hours; it can be done in a Sterling in a few minutes, as one operation removes all parts at once.

Send us your name; we want to send you our catalogue.

TEMPLETON MANUFACTURING CO.

22 Randolph Street, BOSTON, MASS.

THE LIPPINCOTT INDICATOR

REDUCING WHEEL AND PLANIMETER

You'll get better value for your money with a Lippincott Indicator outfit than you could possibly get elsewhere. We manufacture a remarkably complete line and can give you an instrument at a price which will fit your pocketbook.

Write for our Catalog.

LIPPINCOTT STEAM SPECIALTY AND SUPPLY CO.

Newark, New Jersey.

TRY A "GEIPEL"

STEAM TRAP FOR 30 DAYS

and be convinced.

Works equally well with high or low pressure steam and in any position. Made in seven sizes.

Write for Circulars.

JOHN PLATT & CO., 97 Cedar St., NEW YORK

Accurate Draft Regulation

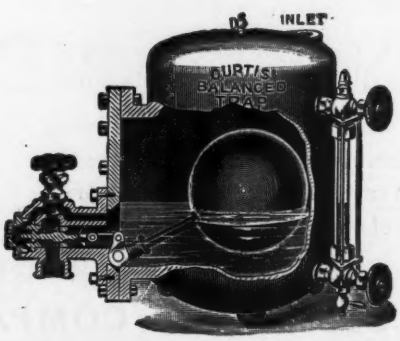
It means a big saving in fuel and labor to have the proper draft at all times.

The Curtis Improved Damper Regulator

is always dependable.

All Curtis Specialties are described in our 1909 Catalog. Write for a copy.

JULIAN D'ESTE CO.,
20 Canal St., Boston, Mass.



Curtis Balanced Steam Trap

When Your Speed Fluctuates

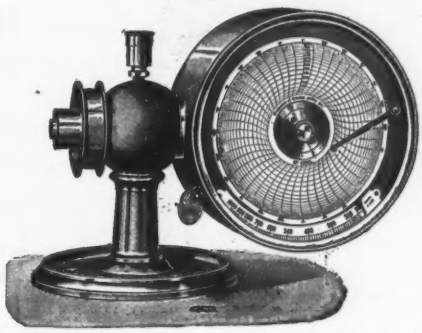
You Lose

STOP THAT LEAK

with an

S. & B.

Tachometer



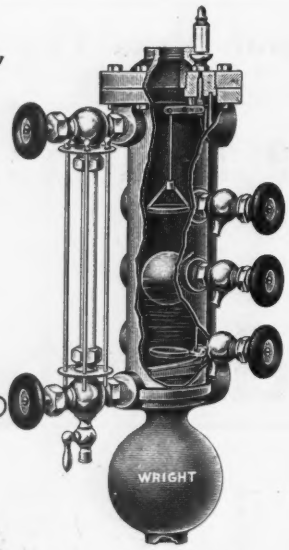
To know the extent of speed fluctuations in high speed engines, dynamos, turbines and all machinery in power plants, provide yourself with an S. & B. Tachometer. It is essential that you know the exact speed at which your engines are running in order to keep them properly adjusted, and no instrument made for this purpose is as efficient and reliable as the S. & B. The apparatus shown above is of the combination recording and indicating type, and owing to its compactness is especially recommended.

We make all kinds of tachometers, high or low speed, portable and stationary, indicating or recording, and all are unfailingly accurate, yet cost no more than imitations. Why buy substitutes?

Let us send you full particulars.

The Schaeffer & Budenberg Manufacturing Company : :
963 Kent Avenue : Brooklyn, N. Y.

High and Low Alarm



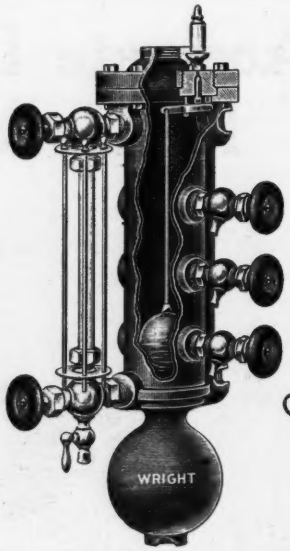
WRIGHT

Improved Safety Alarm Water Column

A government, state and municipally approved means of protecting boilers from disastrous accidents.

SIMPLE
DEPENDABLE
ECONOMICAL

The whistle SHRIEKS in time of danger.



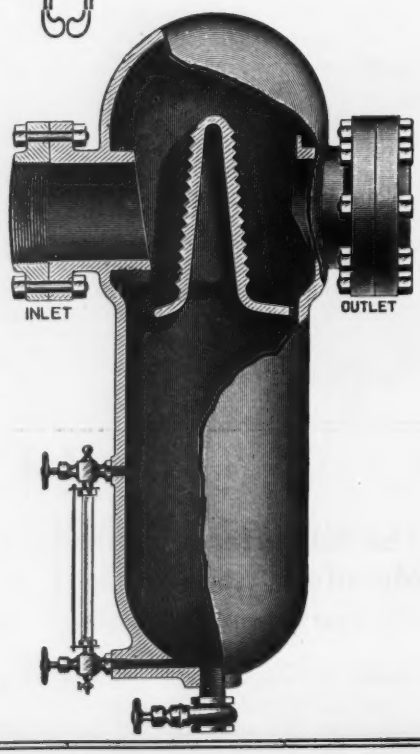
Low Water Alarm

ONE FLOAT
ONE WHISTLE
ONE VERTICAL VALVE

SEND FOR ILLUSTRATED CATALOG

Shipped subject to trial and return at our expense if unsatisfactory.

WRIGHT MANUFACTURING COMPANY
DETROIT, MICHIGAN 72 Woodbridge Street



Austin Figure "E"

Horizontal Iron Receiver Steam Separator

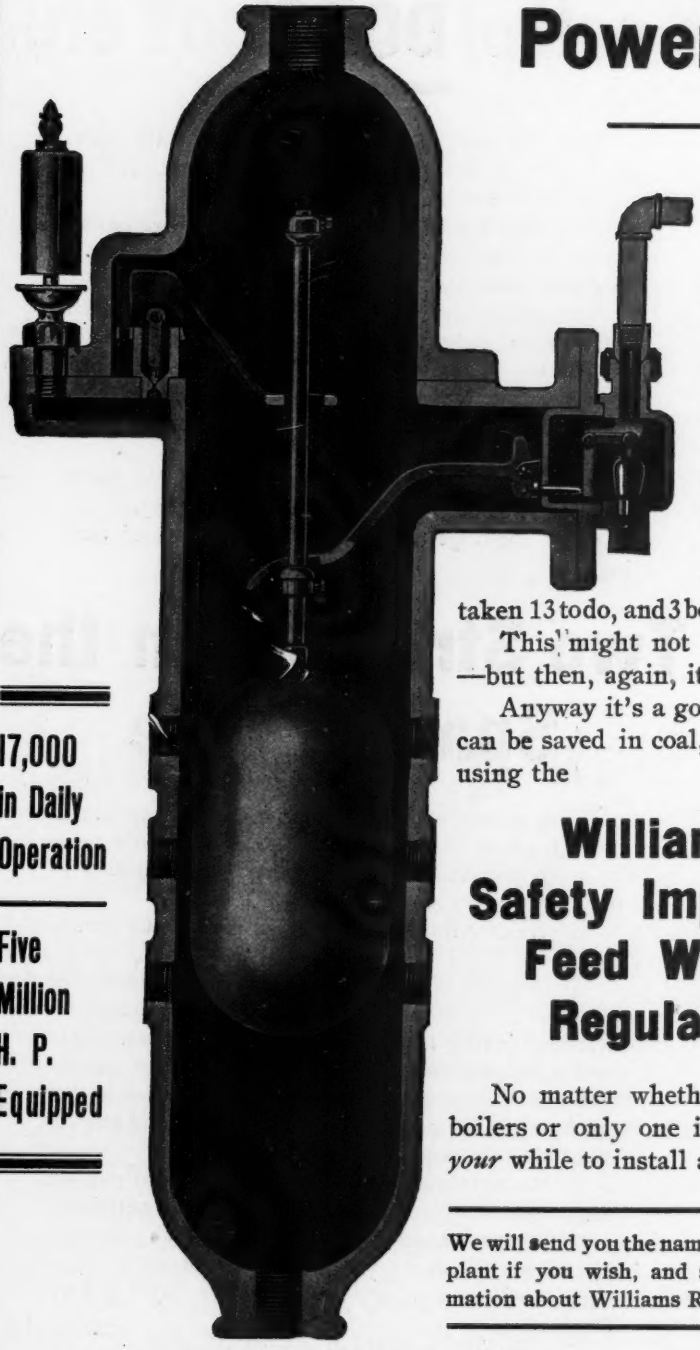
Are you getting good results from the separator you are now using?

AUSTIN SEPARATORS properly installed never fail to do the work.

Try the Figure "E" in your horizontal pipe line. Note the great receiver capacity and the principle of operation. Send for catalog.

AUSTIN SEPARATOR COMPANY
DETROIT, MICHIGAN 23 Woodbridge Street

10 Williams Regulators Saved the Power of 3 Boilers



A paper mill in Colorado bought 13 Williams regulators for its 13 boilers. After installing 10 of the regulators it found that they saved enough so that 10 units would do the work it formerly had taken 13 to do, and 3 boilers were abandoned.

This might not happen in your plant—but then, again, it *might*.

Anyway it's a good indication of what can be saved in coal, steam and labor by using the

Williams Safety Improved Feed Water Regulator

No matter whether you have 13 boilers or only one it will be worth *your* while to install a Williams.

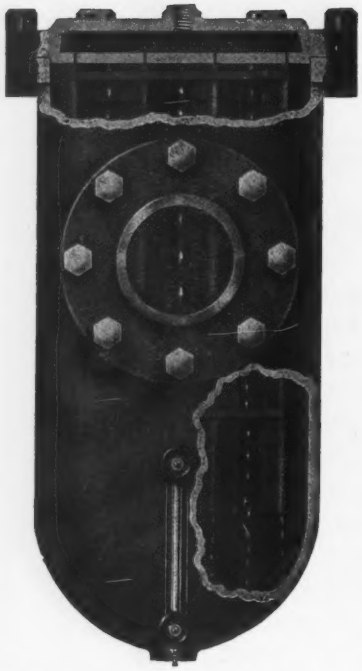
17,000 in Daily Operation

Five Million H. P. Equipped

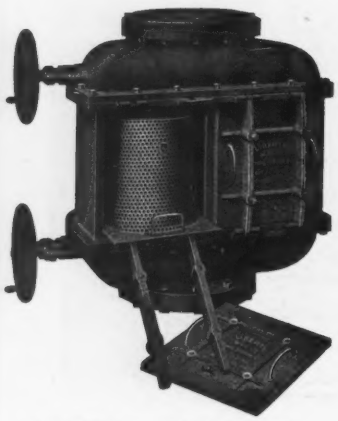
We will send you the name of that Colorado plant if you wish, and some useful information about Williams Regulators.

THE WILLIAMS GAUGE CO., 643 4th Ave., Pittsburg, Pa.

Chicago Office, 218 La Salle St.



LIBERTY–GREENAWAY OIL SEPARATOR



LIBERTY TWIN STRAINER

An Oil Separator that DOES!

Might as well have a **good** separator while you're about it as to have one which just interrupts the exhaust steam flow and doesn't remove the oil.

With the **Liberty-Greenaway Oil Separator** installed on the steam line your exhaust steam will be absolutely free from oil all the time.

There is plenty of room in it—lots of surface to catch the oil and a positive method for holding it.

The top of the separator is easily removable and allows you free access to the whole interior. Now and then, when the separator needs cleaning, you will find this feature mighty handy.

After exhaust steam has passed through the **Liberty-Greenaway** it is clean enough for anything.

How about getting our bulletin—it's worth reading.

Two Strainers in the Space of One

Your pumps, valves, condensers and all apparatus through which the water must flow will get just twice as much protection from a **Liberty Twin Strainer** as they will from a single strainer.

It gives continuous service and continuous protection.

The feature which makes it especially worth your attention is its double straining device. It consists of a casing having 2 passage ways, each containing a basket shaped strainer. These strainers are removable and when one of them becomes clogged it is shut off, by means of a valve, and can be cleaned while the other does the work.

It can be cleaned in a few minutes so that you can use a mesh small enough to clean the water perfectly.

Any plant, large or small, which is liable to have ice, sticks, leaves or refuse of any sort in its water supply will save money and trouble with a **Twin Strainer.**

Bulletin No. 15 will tell you all about it.

LIBERTY MANUFACTURING COMPANY

6409 Susquehanna St., PITTSBURG, PA.

Always Ready the Minute You Want to Use It

Did you ever get all ready to clean boiler tubes and then find that the cleaner was out of order?

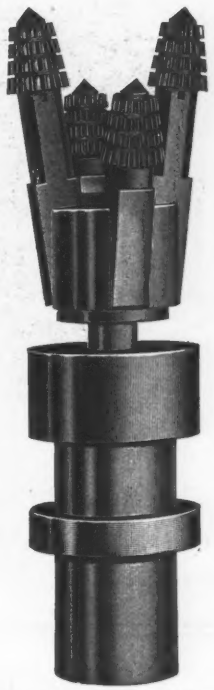
The delay that followed was expensive, but it couldn't be helped—**not with that particular cleaner.**

If it had been a **Cyclone** cleaner equipped with a Norivet cleaner head you could have taken the whole thing apart with your fingers in less than a minute. The simplicity and strength of its construction and its few working parts make it practically wear proof—a feature invaluable to plants requiring frequent cleaning.

The **Cyclone** is made to stand the hardest kind of work and will give you clean-to-the-iron tubes in shorter time and at lower cost than any other cleaner. Contains the best of materials and fine workmanship.

If you have doubts about the Cyclone, **try** it—that is the quickest way to settle them.

Write us about it.



CYCLONE TUBE CLEANER

Pure Oil—Why Not?

The simplest answer to the dirty-oil question is the **Liberty Oil Purifier.**

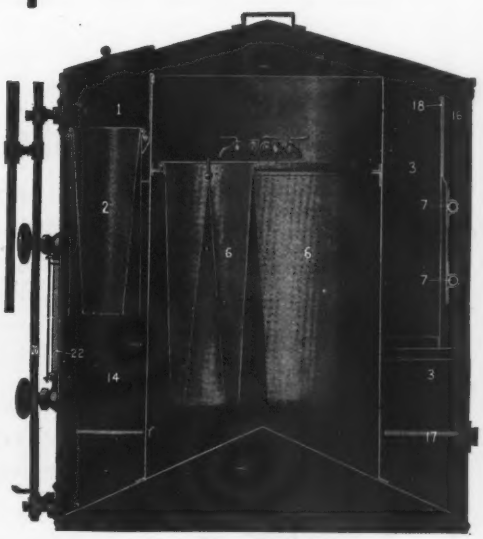
It will take your lubricating oil in any stage of impurity, treat it, then return it to you clean enough for immediate use on any machinery in your plant.

No matter what has contaminated the oil—water, carbon, minute metallic particles, dust or other foreign matter—it all looks alike to the Liberty Purifier.

Its method of purifying is very simple, rapid and practical, and it purifies every drop of oil put into it without injuring the lubricating qualities in the slightest.

Numerous gauges keep you posted all the time as to just how things are going inside the filter. There is never any chance for a hitch.

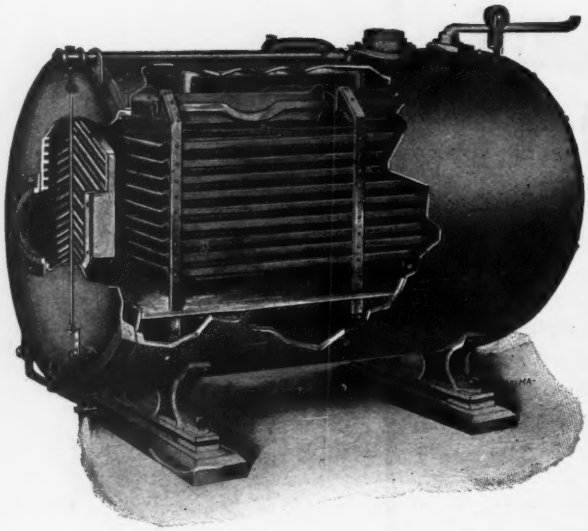
You can get a good idea of how much the Liberty Purifier will save you by reading our Bulletin No. 40.



LIBERTY OIL PURIFIER

LIBERTY MANUFACTURING COMPANY

6409 Susquehanna St., PITTSBURG, PA.



Hoppes Feed-Water Heaters

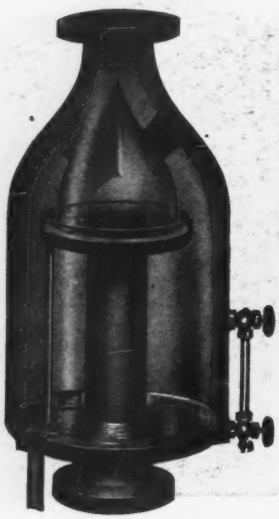
Heat and purify the feed-water to the greatest possible extent because they are properly designed.

They are equipped with efficient oil catchers which remove the oil from the steam before it comes in contact with the water; have a more extensive heating and lime-catching surface than any other Heater on the market, and keep the water, **flowing in thin films** over this surface, in **constant, direct contact** with the steam, securing the full capacity of its heating power.

They are built of either steel or cast iron and in all sizes up to 40,000 H. P.

Our NEW CATALOG No. 40 fully illustrates and describes all the different types of Hoppes Heaters. Let us send you a copy.

Live Steam Feed-Water Purifiers
Exhaust Heads Oil Eliminators



Hoppes Steam Separators

Not only separate the suspended and entrained moisture and supply dry steam to the engine, but their **large receiver capacity** affords an excellent protection against slugs or flushes of water forced into the steam pipe by priming of boilers.

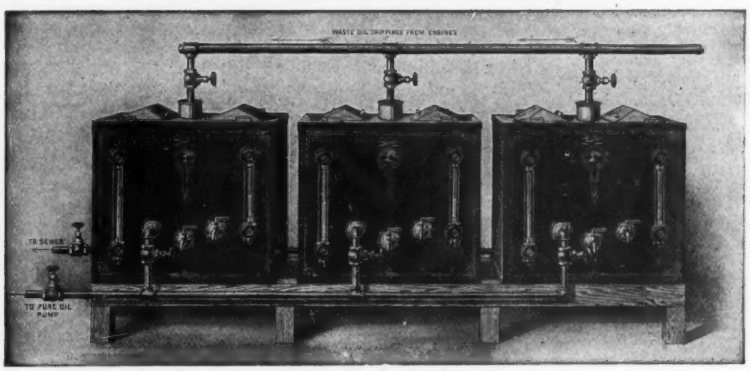
Cast iron construction in Horizontal and Vertical types, sizes up to 9 inches inclusive.

Steel Shell Receiver Separators in all sizes and types to meet requirements.

Write for our Special Separator Catalog.

HOPPES MFG. CO., 70 Larch St., Springfield, Ohio.

They Have a Battery of Seven Units



Three "Units" Connected and Operated as One Filter

The Burt System Continues to Give Excellent Results

Nazareth Cement Company,
NAZARETH, PA., April 25, 1908.

The Burt Mfg. Co., Akron, O.

Gentlemen—We are pleased to report that the battery of seven "Unit Type" Filters which we purchased from your company are now in operation, and have been for some time, and we find your filtering system to be satisfactory. Your favor of the 20th inst.

Yours very truly,
NAZARETH CEMENT COMPANY.

Not alone does the "Burt" give excellent results, but it saves largely on the amount of oil consumed.
SEND FOR OUR NEW 96-PAGE CATALOG.

THE BURT MFG. CO., 204 Main St., Akron, O., U. S. A.

Largest Manufacturers of Oil Filters in the World

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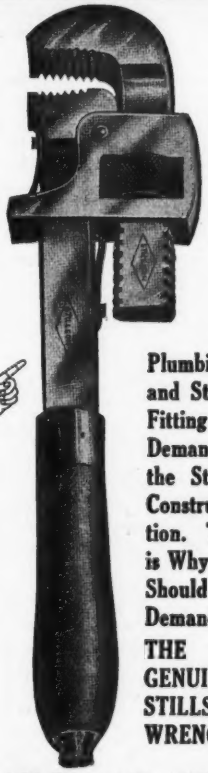
IF THIS MARK IS ON THE WRENCH IT'S THE GENUINE



You Needn't Worry about the Quality in it.

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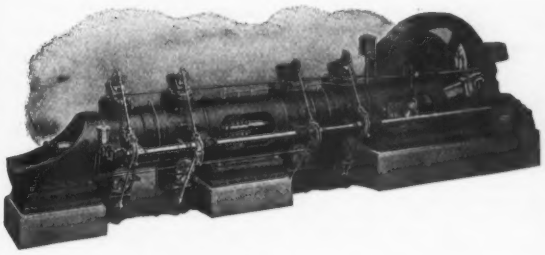
Plumbing and Steam Fitting Demands the Stiffest Construction. That is Why You Should Demand THE GENUINE STILLSON WRENCH.

WALWORTH MFG. COMPANY, 128 Federal St., BOSTON
New York Office, Park Row Bldg.

The Buckeye Four-Stroke Cycle Gas Engine.

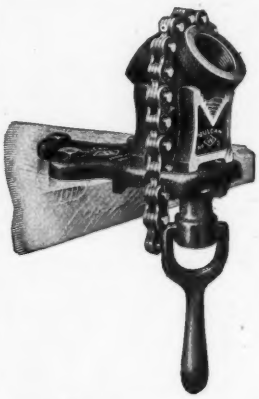
Double and Single acting. Simple, Durable, Economical.



In Powers from 50 to 6,000 Horses.

Catalogs on application.

BUCKEYE ENGINE CO.,
Salem, Ohio.



Where else can you

Find It?

A Unbreakable Tool
No cost for repairs.

A Compact Tool
Folded 6x8x8; carry it in your hands or tool bag; "just a handful" covers it exactly.

Quick in Action
Rapid lead in screw; a child can adjust to stay; grip is non-crushing.

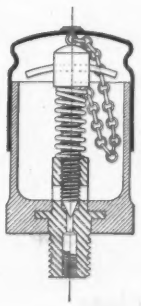
Capacity 1-8 to 4"
Nothing like it anywhere; a tool guaranteed beyond comparison in details, wear and service.

"Vulcan" Chain Pipe Vise

J. H. Williams & Co.
Superior Drop Forgings
BROOKLYN, NEW YORK

Get Free Catalog "P-E'09"

The Low Price of This Oil Cup Will Interest You



The "INDESTRUCTIBLE" Oil Cup.

It has a machinery steel shank, that prevents breakage at that vulnerable point.

Write for particulars.

The U. S. Metallic Packing Company
431 North 13th St., Philadelphia, Pa.

Classified Directory of Power Plant Apparatus and Supplies

To find the Announcement of Manufacturers named in this Directory Refer to Alphabetical Index.

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Reliance Gauge Column Co., Cleveland, O.
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Wright Mfg. Co., Detroit, Mich.

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Arctic Ice Machine Co., Canton, O.
York Mfg. Co., York Pa.

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National Tube Co., Pittsburg, Pa.

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N. Y. Leather Belting Co., New York. "Phoenix," "Edge-On."
Peerless Rubber Co., New York. "Rainbow," "Fortune," "Durham."
Quaker City Rubber Co., Philadelphia. "Ironsides."
Sawyer Belting Co., Cleveland, O.
Simmons Co., John, New York.

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Dixon Crucible Co., Jos., Jersey City.
Gandy Belting Co., Baltimore, Md.
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Walton Co., F. S., Philadelphia, Pa. "Ox-Oil-Ox."

BELT FASTENERS.
Greene, Tweed & Co., New York. "Morans."
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BLOWERS.
"Diamond" Power Specialty Co., Detroit, Mich. "Diamond."
Monarch Steam Blower Co., Troy, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

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Indicator Instruction Co., Newark, N. J.
McClave-Brooks Co., Scranton, Pa. "Argand."

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Scully Steel & Iron Co., Chicago.

BOILER DOOR ARCHES.
McLeod & Henry Co., Troy, N. Y. "Steel Mixture."

BOILER FEEDERS.
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Davis Regulator Co., G. M., Chicago.
Dean Bros. Steam Pump Works, Indianapolis, Ind. "Atlantic."
Lunkenheimer Co., The, Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, O.
Randle Machinery Co., Cincinnati, O.
Wheeler Mfg. Co., C. H., Philadelphia.

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American Steam Gauge & Valve Mfg. Co., Boston.
Hughson Steam Specialty Co., Chicago. "Eclipse."
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BOILER SETTINGS.
McLeod & Henry Co., Troy, N. Y. "Steel Mixture."

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National Tube Co., Pittsburg, Pa.
Hughson Steam Specialty Co., Chicago.

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Brownell Co., The, Dayton, O.
Chicago House Wrecking Co., Chicago, Ill.
Erie City Iron Works, Erie, Pa.
Heine Safety Boiler Co., St. Louis.
Randle Machinery Co., Cincinnati, O.
Robb-Mumford Boiler Co., Amherst, Nova Scotia
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BOLT STOCKS.
Borden Co., Warren, O. "Solid-Adjustable."

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American School of Correspondence. Chicago, Ill.
Audel & Co., Theo., New York.
Branch Publishing Co., Chicago.
International Correspondence Schools. Scranton, Pa.

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BORING BARS.
Underwood & Co., H. B., Philadelphia, Pa.

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Powell Co., The Wm., Cincinnati, O.

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Armstrong Mfg. Co., Bridgeport, Conn.
National Tube Co., Pittsburg, Pa.

CABLES.
American Steel & Wire Co., Chicago.
Columbian Rope Co., Auburn, N. Y.

CALOROMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CASTINGS.
Homestead Valve Co., Homestead. Pa.
Hooven, Owens, Rentschler Co., Hamilton, O.
Walworth Mfg. Co., Boston, Mass.

CEMENT, ASBESTOS.
Johns-Manville Co., H W., New York.
New York Belting & Packing Co., Ltd., New York.

CEMENT, IRON.
Smooth-on Mfg. Co., Jersey City,

CLAMPS, ROPE.
American Steel & Wire Co., Chicago.

CLAMP, STEAM JOINT.
McCrea & Co., James, Chicago. "Emergency," "Climax."

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Industrial Instrument Co., Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

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d'Este Co., Julian, Boston, Mass.
Industrial Instrument Co., Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
National Tube Co., Pittsburg, Pa.
Powell Co., The Wm., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."
Simmons Co., John, New York.
Williams Valve Co., D. T., Cincinnati, O.

COCKS, BLOW-OFF.
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Lunkenheimer Co., The, Cincinnati, Ohio.
Williams Gauge Co., Pittsburg, Pa.

COCKS, STOP.
Dart Mfg. Co., E. M., Providence, R. I.
National Tube Co., Pittsburg, Pa.

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Binghamton Boiler Compound Co., Binghamton, N. Y. "Pyramid Brand."
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National Water Softener Sales Co., Indianapolis, Ind.

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Arctic Ice Machine Co., Canton, O.

COMPRESSORS, POWER AIR.
American Steam Pump Co., Battle Creek, Mich.

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Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Buckeye Engine Co., Salem, O.
Du Bois Iron Works, Du Bois, Pa.
Gilson Mfg. Co., Fort Washington, Wis.
Jacobson Engine Co., Chester, Pa.
Miller Improved Gas Engine Co., Springfield, O.
New York Engine Co., New York.
Otto Gas Engine Works, Philadelphia, Pa.
Schiller & Co., Philadelphia, Pa.
Tower Engineering Co., Buffalo, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

ENGINES, OIL.
Du Bois Iron Works, Du Bois, Pa.

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Bates Machine Co., Joliet, Ill.
Ball Engine Co., Erie, Pa.
Brownell Co., The, Dayton, O.
Buckeye Engine Co., Salem, O.
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Erie City Iron Works, Erie, Pa.
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Hooven, Owens, Rentschler Co., Hamilton, O. "Hamilton-Corliss."
Randle Machinery Co., Cincinnati, O.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Russell Engine Co., Massillon, O.
Schiller & Co., Philadelphia, Pa.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
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Keystone Chem. Mfg. Co., Philadel-
National Water Softener Sales Co., Indianapolis, Ind. phia, Pa.
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Brownell Co., The, Dayton, O.
Chicago House Wrecking Co., Chicago, Ill.
Erie City Iron Works, Erie, Pa
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Harrison Safety Boiler Works, Philadelphia, Pa.
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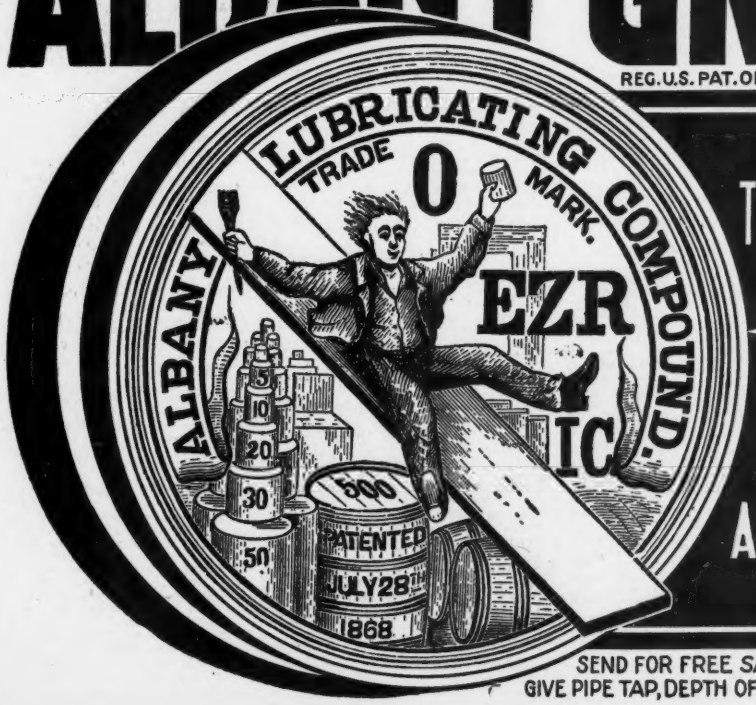

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Flower, Walter L., Steam Specialty Co., St. Louis, Mo. "Acme."
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Lunkenheimer Co., The, Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
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Jerguson Mfg. Co., Boston, Mass. "Reflex."
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Penberthy Injector Co., Detroit, Mich.
Powell Co., Wm., Cincinnati, O.
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American Steam Gauge & Valve Mfg. Co., Boston, Mass. "American Hydraulagraph."

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Powell Co., The Wm., Cincinnati, O.
Reliance Gauge Column Co., Cleveland, O.
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Greene, Tweed & Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
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Lunkenheimer Co., Cincinnati, O.
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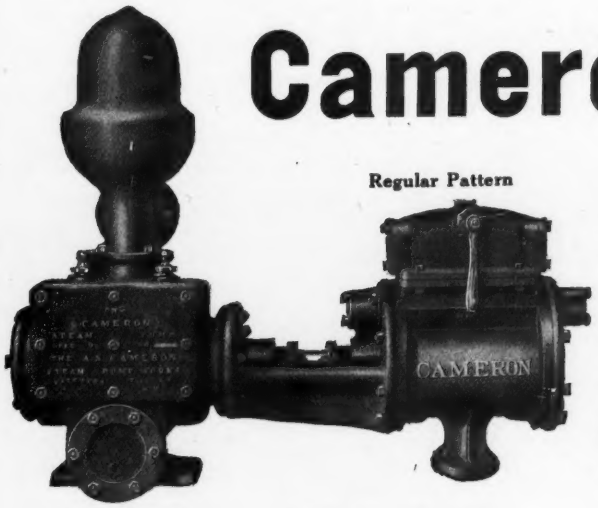
Penberthy Injector Co., Cincinnati, Ohio.
Philadelphia Lubricating & Mfg. Co., Philadelphia, Pa.
Powell Co., The Wm., Cincinnati, O.
U. S. Metallic Packing Co., Philadelphia, Pa. "Indestructible."
Williams Valve Co., D. T., Cincinnati, O.

OIL TANKS.
Burt Mfg. Co., Akron, O.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Wright Mfg. Co., Detroit, Mich.

PACKINGS.
Allan & Son, A., New York. "Allan Metal."
American Goetze-Gasket & Packing Co., New Brunswick, N. J.
American Huhn Metallic Packing Co., New York.
Burgmann, Feodor, New York, "Janos-Plate."
Cancos Mfg. Co., Philadelphia, Pa. "Black Squadron."
Canfield Mfg. Co., Philadelphia, Pa. "Ambest."
Carpenter & Co., Geo. B., Chicago. "Rainbow," "Peerless," "Eclipse."
Detroit Leather Specialty Co., Detroit, Mich. "Wearwell."
Eureka Packing Co., New York.
Federal Metallic Packing Co., Boston, Mass.
France Packing Co., Inc., Tacony, Pa.
Greene, Tweed & Co., New York. "Palmetto."
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Jenkins Bros., New York. "Jenkins '96."
Johns-Manville Co., H. W., New York.
Kendrick Valve & Washer Co., Syracuse, N. Y. "Standard."
Mabbs Hydraulic Packing Co., Chicago, Ill.
Mechanical Rubber Co., Cleveland, O. "Marco," "Karbonite," "Ruby Red."
N. Y. Belting & Packing Co., Ltd., New York. "Karbonite."
Peerless Rubber Mfg. Co., New York. "Rainbow," "Eclipse."
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Quaker City Rubber Co., Philadelphia. "Ebonite," "P. P. P."
Robertson & Sons, Jas. L., New York. "Eureka."
Schiller & Co., Philadelphia, Pa.
Simmons Co., John, New York.
Smooth-on Mfg. Co., Jersey City, N. J.

The Slogan of the Cameron—"Character: The Grandest Thing"

Cameron Pumps



Regular Pattern

Simplicity and Reliability

are the features most sought for and in demand in the regular service of a steam pump

Look at the sectional view of a

Cameron Regular Pattern Pump

The working parts in these pumps, reduced to the smallest number, are simple, substantial and readily accessible. There is no extremely located valve gear, subject to damage or derangement.

The capacity of a Cameron Pump is determined by the speed at which it is operated, normal or abnormal. It has no dead center and will start in any part of the stroke, and every stroke is fully completed whether the pump is running at the highest speed, or so slowly that motion is barely perceptible. Moreover, its simplicity enables it to be run safely at the highest speed, and every Cameron Pump is packed to compensate for wear.

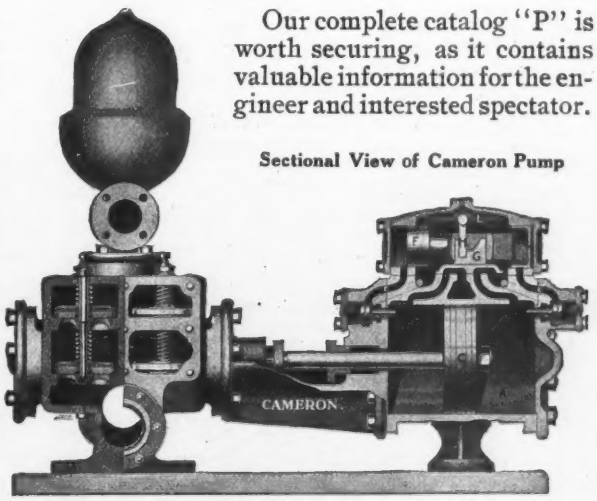
Cameron Pumps are built for every purpose.

are recognized everywhere by their "Acorn-Shaped Air Chamber;" the emblem of the clan and the patented trademark of the house. But they are distinguished by their sterling qualities and conceded superiority.

Our fifty years of experience in the pump business has enabled us to render exceptional service to our customers; and users everywhere will testify to the long life and economy in maintenance and repairs of all Cameron types.

Our complete catalog "P" is worth securing, as it contains valuable information for the engineer and interested spectator.

Sectional View of Cameron Pump



A. S. CAMERON STEAM PUMP WORKS

Foot of East Twenty-Third Street, NEW YORK

Dec. '09

Classified Directory of Power Plant Apparatus and Supplies—Continued

Steel Mill Packing Co., Detroit, Mich. "Safety."
Thermold Rubber Co., Trenton, N. J. "Solaroid."
Wilpaco Packing Co., New York.

PIPE, WOOD.
American District Steam Co., Lockport, N. Y. "Standard."

PIPE, WROUGHT IRON AND STEEL.
National Tube Co., Pittsburg, Pa.
Simmons Co., John, New York.

PIPE BENDING.
National Pipe Bending Co., New Haven, Conn.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.

PIPE COILS, IRON AND BRASS.
National Pipe Bending Co., New Haven, Conn.
Simmons Co., John, New York.
Whitlock Coil Pipe Co., Hartford, Conn.

PIPE COVERINGS.
Johns-Manville Co., H. W., New York.
Simmons Co., John, New York.

PIPE CUTTERS.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis, Bridgeport, Conn. "Forbes."
Simmons Co., John, New York.
Williams & Co., J. H., Brooklyn, N. Y.

PIPE THREADING MACHINES.
Armstrong Mfg. Co., Bridgeport. Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill. "P. D. Q. C."
Borden Co., Warren, O. "Solid-Adjustable."
Curtis & Curtis Co., Bridgeport, Conn. "Forbes."
Simmons Co., John, New York.
Williams & Co., J. H., Brooklyn, N. Y.

PLANIMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York. "Willis."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."

PLUNGER STUFFING BOX.
Schiller & Co., Philadelphia, Pa.

POWER PLANT EQUIPMENT.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

PRESSURE REGULATORS.
Davis Regulator Co., G. M., Chicago.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston. "Curtis."
Foster Engineering Co., Newark, N. J.
Hughson Steam Specialty Co., Chicago, Ill. "Eclipse."
Robertson & Sons, Jas. L., New York.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia. "McDaniels."

PULLEYS.
American Pulley Co., Philadelphia.
Columbian Rope Co., Auburn, N. Y.

PUMPS.
Alberger Condenser Co., New York.
American Steam Pump Co., Battle Creek, Mich. "Marsh" and "American."
Cameron Steam Pump Works, A. S., New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, O.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca, Falls, N. Y.
Lunkenheimer Co., Cincinnati, O.
National Steam Pump Co., Upper Sandusky, O.
Otto Gas Engine Works, Philadelphia, Pa.
Randle Machinery Co., Cincinnati, O.
Stewart Heater Co., Buffalo, N. Y.

PUMPS, BOILER FEED.
Alberger Condenser Co., New York.
American Steam Pump Co., Battle Creek, Mich. "American."
Goulds Mfg. Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.

PUMPS, CENTRIFUGAL.
Alberger Condenser Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.

PUMPS, COMPOUND.
American Steam Pump Co., Battle Creek, Mich. "American."
Cameron Steam Pump Works, New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
National Steam Pump Co., Upper Sandusky, O.

PUMPS, CONDENSATION.
American Steam Pump Co., Battle Creek, Mich. "Marsh."
Cameron Steam Pump Works, A. S., New York.

PUMPS, DEEP WELL.
American Steam Pump Co., Battle Creek, Mich. "Marsh."
Cameron Steam Pump Works, New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, O.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.

PUMPS, ELEVATOR.
American Steam Pump Co., Battle Creek, Mich. "American."
Cameron Steam Pump Works, A. S., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.

PUMPS, FIRE.
American Steam Pump Co., Battle Creek, Mich. "American."
Cameron Steam Pump Works, A. S., New York.
National Steam Pump Co., Upper Sandusky, O.

PUMPS, HYDRAULIC PRESSURE.
American Steam Pump Co., Battle Creek, Mich. "American."
Cameron Steam Pump Works, A. S., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.

PUMPS, JET.
Cameron Steam Pump Works, A. S., New York.
Randle Machinery Co., Cincinnati, O.

PUMPS, OIL.
American Injector Co., Detroit, Mich.
American Steam Pump Co., Battle Creek, Mich. "Marsh."
Cameron Steam Pump Works, New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, O.
Detroit Lubricator Co., Detroit, Mich.
Goulds Mfg. Co., Seneca Falls, N. Y.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
National Steam Pump Co., Upper Sandusky, O.
Penberthy Injector Co., Detroit, Mich.
Powell Co., The, Cincinnati, O.
Sight Feed Oil Pump Co., Milwaukee. "Richardson."
Williams Valve Co., D. T., Cincinnati, O.

PUMPS, POWER.
American Steamp Pump Co., Battle Creek, Mich. "American."
Cameron Steam Pump Works, New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, O.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.
Stewart Heater Co., Buffalo, N. Y.

PUMPS, SINKING.
American Steam Pump Co., Battle Creek, Mich. "Marsh."
Cameron Steam Pump Works, A. S., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.

PUMPS, TANK.
American Steam Pump Co., Battle Creek, Mich. "Marsh" and "American."
Cameron Steam Pump Works, A. S., New York.
Goulds Mfg .Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.

PUMPS. TWIN BEAM AIR.
Cameron Steam Pump Works, A. S., New York.

PUMPS, VACUUM.
Alberger Condenser Co., New York.
American Steam Pump Co., Battle Creek, Mich. "Marsh."
Cameron Steam Pump Works, New York.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Goulds Mfg. Co., Seneca Falls, N. Y.
National Steam Pump Co., Upper Sandusky, O.

PUNCHES.
Greene, Tweed & Co., New York.

PURIFIERS.
American Water Softener Co., Philadelphia.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Keystone Chem. Mfg. Co., Philadelphia.
National Water Softener Sales Co., Indianapolis, Ind.
New York Continental Jewell Filtration Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.

PYROMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, New York.

RECORDING INSTRUMENTS.
American Steam Gauge & Valve Mfg. Co., Mass. "Standard."
Industrial Instrument Co., Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."
Standard Gauge Mfg. Co., Foxboro, Mass.

REDUCING WHEELS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York. "Victor."

REFRIGERATING MACHINERY.
York Mfg. Co., York Pa.

REGULATOR, DAMPER.
Davis Regulator Co., G. M., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Watson & McDaniel Co., Philadelphia.
Wilkinson Mfg. Co., Bridgeport, Pa.
Williams Gauge Co., Pittsburg, Pa.

REGULATORS, FEED WATER.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg. "Vigilant."
Davis Regulator Co., G. M., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Foster Engineering Co., Newark, N. J.
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia.
Williams Gauge Co., Pittsburg, Pa.

REPAIRS.
Griscom-Spencer Co., New York.
Hartford Engine Wks., Hartford, Conn.
Schiller & Co., Philadelphia, Pa.
Underwood & Co., H. B., Philadelphia, Pa.

RESEATING MACHINES.
Lagonda Mfg. Co., Springfield, O.
Quaker City Rubber Co., Philadelphia, Pa.

ROPE, HEMP.
Columbian Rope Co., Auburn, N. Y.

ROPE, WIRE
American Steel & Wire Co., Chicago.

ROPE DRESSING AND PRESERVATIVE.
Cling-Surface Co., Buffalo, N. Y.

SEPARATORS, AMMONIA.
Direct Separator Co., Syracuse, N. Y.
Williams Valve Co., D. T., Cincinnati, O.

SEPARATORS & EXTRACTORS, STEAM & OIL.
Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Direct Separator Co., Syracuse, N. Y.
Hershey Machine & Foundry Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa. "Greenaway."
Ohio Blower Co., Cleveland, O. "Swartwout."
Simmons Co., John, New York.
Watson & McDaniel Co., Philadelphia, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.
Williams Valve Co., The, D. T., Cincinnati.
Wright Mfg. Co., Detroit, Mich.

SIPHONS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

SKYLIGHTS.
Burt Mfg. Co., Akron, Ohio.

SPECIAL MACHINERY.
American District Steam Co., Lockport, N. Y.
Schiller & Co., Philadelphia, Pa.
Underwood & Co., M. B., Philadelphia, Pa.

SPECIALTIES, STEAM.
American Injector Co., Detroit, Mich.
American Steam Gauge & Valve Mfg. Co., Boston.
Davis Regulator Co., G. M., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Griscom-Spencer Co., New York.
Hoppes Mfg. Co., Springfield, O.
Hughson Steam Specialty Co., Chicago. "Eclipse."
Industrial Instrument Co., Foxboro, Mass. "Standard."
Lunkenheimer Co., The, Cincinnati, O.
Foster Engineering Co., Newark, N. J.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jerguson Mfg. Co., Boston, Mass. "Wiltbonco."
Lippincott Steam Specialty & Supply Co., Newark, N. J.
McCrea & Co., James, Chicago.
Nason Mfg. Co., New York.
National Tube Co., Pittsburg, Pa.
Penberthy Injector Co., Detroit, Mich.
Reliance Gauge Column Co., Cleveland.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."
Simmons Co., John, New York.
Strong, Carlisle & Hammond Co., Cleveland, O.
Williams Gauge Co., Pittsburg, Pa.
Williams Valve Co., The D. T., Cincinnati.
Watson & McDaniel Co., Philadelphia.
Wright Mfg. Co., Detroit, Mich.

STEAM HEATING SYSTEM.
STEAM METERS.
St. John, G. C., New York.

STEAM TRAPS.
Amer. Dist. Steam Co., Lockport, N. Y. "Empire."
Anderson Co., The V. D., Cleveland, O. "Improved."
Davis Regulator Co., G. M., Chicago.
d'Este Co., Julian, Boston. "Curtis."
Direct Separator Co., Syracuse, N. Y.
Hughson Steam Specialty Co., Chicago. "Eclipse."
Jenkins Bros., New York. "Diamond."
Kitts Mfg. Co., Oswego, N. Y.
McCrea & Co., James, Chicago. "H. H."
Nason Mfg. Co., New York. "Sidelug."
National Tube Co., Pittsburg, Pa.
Platt & Co., John, New York. "Gelpel."
Reliance Gauge Column Co., Cleveland.
Simmons Co., John, New York.
Strong, Carlisle & Hammond Co., Cleveland, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Templeton Mfg. Co., Boston, Mass. "Sterling."
Watson & McDaniel Co., Philadelphia, Pa.
Williams Gauge Co., Pittsburg, Pa.
Williams Valve Co., Cincinnati, O. "Cookson."
Wright Mfg. Co., Detroit, Mich "Emergency."

STOCKS AND DIES.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Borden Co., Warren, O. "Solid-Adjustable."
Curtis & Curtis Co., Bridgeport Conn. "Forbes."

STOKERS, MECHANICAL.
Erie Foundry Co., Erie, Pa.
Murphy Iron Works, Detroit, Mich.
Underfeed Stoker Co., Chicago. "Jones."
Westinghouse Machine Co., Pittsburg, Pa. "Roney."
Wilkinson Mfg. Co., Bridgeport, Pa.
Otto Gas Engine Works, Philadelphia.
Randle Machinery Co., Cincinnati, O.
Simmons Co., John, New York.

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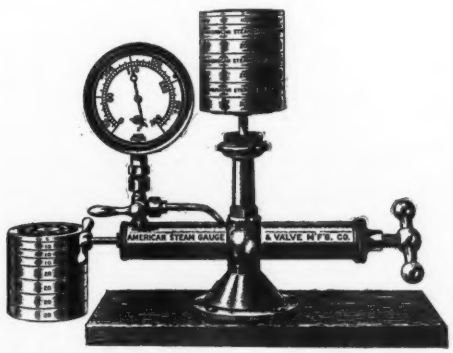

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Westinghouse Machine Co., Pittsburg, Pa.

STRAINERS.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Deming Co., The, Salem, O.
Gonlds Mfg. Co., Seneca Falls, N. Y.
Liberty Mfg. Co., Pittsburg, Pa. "Twin."
Lunkenheimer Co., The, Cincinnati.
Ohio Injector Co., Wadsworth, O.

SUPERHEATERS, STEAM.
Heine Safety Boiler Co., St. Louis.
Whitlock Coil Pipe Co., Hartford, Conn.

SUPPLIES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

SWITCHBOARDS.
Fort Wayne Electric Works, Fort Wayne, Ind. "Wood Systems."
General Electric Co., Schenectady, N. Y. "G. E."
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

TACHOMETERS.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."
Industrial Instrument Co., Foxboro, Mass. "Standard."

TANKS, OIL AND WATER.
Baragwanath & Son, Wm., Chicago.

TAPE, STEEL MEASURING.
Keuffel & Esser Co., Hoboken, N. J. "K. & E."
Starrett Co., L. S., Athol, Mass.

THERMOMETERS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co. ,Boston, Mass.
Industrial Instrument Co., Foxboro, Mass. "Standard."
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. "S. & B."
Simmons Co., John, New York.

TOOLS AND SUPPLIES.
Mound Tool & Scraper Co., St. Louis.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Otto Gas Engine Works, Philadelphia.
Starrett Co., L. S., Athol, Mass.
Underwood & Co., H. B., Philadelphia, Pa.

TRANSMISSION ROPE.
American Steel & Wire Co., Chicago.
Columbian Rope Co., Auburn, N. Y.

TUBE CLEANERS.
Claflin & Co., Chas. A., Boston, Mass. "Comet." "Volcano."
"Diamond" Power Specialty Co., Detroit, Mich. "Diamond."
Johns-Manville Co., H. W., New York.
Lagonda Mfg. Co., Springfield, O. "Weinland."
Liberty Mfg. Co., Pittsburg, Pa. "Cyclone." "Standard."
McCrea & Co., James, Chicago.
Monarch Steam Blower Co., Troy, N. Y.
Roto Company, Hartford, Conn.
Scully Steel & Iron Co., Chicago. "Perfection."
Stewart Heater Co., Buffalo, N. Y.

TUBE CUTTERS.
Lagonda Mfg. Co., Springfield, O.

TUBING.
National Tube Co., Pittsburg, Pa.

TURBINES, STEAM.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y. "G. E."
Hooven, Owens, Rentschler Co., Hamilton, O. "Hamilton-Holswarth."
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., Pittsburg, Pa. "Westinghouse-Parsons."

UNDERGROUND HEATING SYSTEM.
American District Steam Co., Lockport, N. Y. "Holly."

UNIONS.
Dart Mfg. Co., E. M., Providence, R. I.
Lunkenheimer Co., The, Cincinnati.
National Tube Co., Pittsburg, Pa. "Kewanee."
Powell Co., The Wm., Cincinnati, O.
Williams, Franklin, New York. "Tuxeda."
Williams Valve Co., D. T., Cincinnati, O.

VALVES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Cameron Steam Pump Works, A. S., New York.
Davis Regulator Co., G. M., Chicago.
Deming Co., The, Salem, O.
d'Este Co., Julian, Boston. "Curtis."
Detroit Lubricator Co., Detroit, Mich.
Foster Engineering Co., Newark, N. J.
Homestead Valve Mfg. Co., Homestead, Pa.
Hughson Steam Specialty Co., Chicago.
Jenkins Bros., New York.
Kitts Mfg Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa. "Faber."
Lunkenheimer Co., The, Cincinnati. "Duro."
National Tube Co., Pittsburg, Pa.
Pittsburgh Valve Foundry and Construction Co., Pittsburg, Pa.
Powell Co., The Wm., Cincinnati, O. "White Star."
Sculley Steel & Iron Co., Chicago. "Everlasting."
Simmons Co., John, New York. "Rothschild."
Strong, Carlisle & Hammond Co., Cleveland, O.
Walworth Mfg. Co., Boston, Mass.
Watson & McDaniel Co., Philadelphia, Pa.
Williams Valve Co., The D. T., Cincinnati, O.

VALVES, BALANCED.
Claflin & Co.. Chas. A., Boston, Mass. "Telescope."

VALVES, HYDRAULIC.
American Steam Gauge & Valve Co., Boston, Mass. "Special."
National Tube Co., Pittsburg, Pa.

VALVES, PUMP.
Cameron Steam Pump Works, A. S., New York.
Jenkins Bros., New York.
Kendrick Valve & Washer Co., Syracuse, N. Y.
Mechanical Rubber Co., Cleveland, O.
Quaker City Rubber Co., Philadelphia, Pa.

VALVES, RELIEF.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Deming Co., The, Salem, O.
Hughson Steam Specialty Co., Chicago. "Kearn."
Industrial Instrument Co., Foxboro, Mass.

VALVES, POP SAFETY.
American Steam Gauge & Valve Co., Boston, Mass. "Special."
Lunkenheimer Co., The, Cincinnati.
National Tube Co., Pittsburg, Pa.
Pittsburgh Valve Foundry and Construction Co., Pittsburg, Pa.

VENTILATING APPARATUS.
Sturtevant Co., B. F., Hyde Park, Mass.

VENTILATORS.
Burt Mfg. Co., Akron, O.

VISES, PIPE.
Williams & Co., J. H., Brooklyn, N. Y.

WASHERS, LEATHER.
Kendrick Valve & Washer Co., Syracuse, N. Y.

WATER COLUMNS AND ALARMS.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Hughson Steam Specialty Co., Chicago. "Eclipse."
Jerguson Mfg. Co., Boston, Mass. "Reflex."
Lunkenheimer Co., The, Cincinnati.
Reliance Gauge Column Co., Cleveland, O.
Simmons Co., John, New York.
Wright Mfg. Co., Detroit, Mich.

WATER SOFTENING SYSTEMS.
American Water Softening Co., Philadelphia, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
New York Continental Jewell Filtration Co., New York.
Otto Gas Engine Works, Philadelphia, Pa.

WHISTLES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., The, Cincinnati.
Powell Co., The Wm., Cincinnati, O.
Simmons Co., John, New York.

WIRE.
American Steel & Wire Co., Chicago.

WRENCHES.
Curtis & Curtis, Bridgeport, Conn.
Greene, Tweed & Co., New York.
Simmons Co., John, New York.
Williams & Co., J. H., Brooklyn, N. Y. "Vulcan," "Big Six."

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1 28x56 Buckeye Girder Frame Automatic Engine.
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1 16x16 New York Safety Automatic Engine.
1 15½x16 Armington & Sims Automatic Engine.
1 15x15 Phoenix Automatic Engine.
1 9x12 Ideal Automatic Engine.
1 18x42 Allis Right Hand Corliss Engine.
1 18x36 Weatherhill Right Hand Corliss Engine.
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MACHINE SHOP TOOLS.
1 4½' Plain Universal Radial Drill Press.
1 4½' Plain Gang & Co. Radial Drill Press.
1 5' Full Universal Bicksford Radial Drill Press.
1 36"x26' New Haven Engine Lathe.
1 36"x14' Walburn & Swenson Engine Lathe.
1 28"x14' Blaisdell Engine Lathe.
1 18"x10' Wight & Powell Engine Lathe.
3 30" Prentiss Bros. Vertical Drill Presses, with sliding heads.
2 20" Silvers Mfg. Co. Drill Presses, new.

WOOD WORKING MACHINERY.
1 44" McDonough Band Resaw, with 3" saws.
1 30" 3 Drum Invincible Sander.
1 30" Single Drum Berlin Sander.
1 Houston Vertical Mortiser and Boring Machine.
1 Daniels Timber Planer.
1 22"x12' Iron Frame Wood Turning Lathe.

MISCELLANEOUS.
1 9x15 Allis-Chalmers Jaw Crusher.
1 7x9 Clayton Belt Driven Compressor.
2 6x8 O. & S. D. C. S. D. Reversible Hoists.
1 No. 2 Root Blower, steam driven.
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1 No. 8 Morris Centrifugal Pump, steam driven.
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VERTICAL ENGINES.
4 7x7 Mansfield Center Crank Engines, new.
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2 3½x5 Mansfield Vertical Engines, new.
1 7x7 Racine Automatic Vertical Engine.
1 7x9 Troy Vertical Engine.
1 7x9 Wachs Vertical Engine.
1 7x8 Wachs Vertical Engine.
1 7x8 New York Safety Automatic Vertical Engine.

STEAM PUMPS.
12 6x4x6 Deam Duplex Steam Pumps, new.
16 4½x2¾x4 Dean Duplex Steam Pumps, new.
8 3x2x3 Dean Duplex Steam Pumps, new.
1 16x12x10 Worthington Duplex Steam Pump.
1 14x7x10 Dean Duplex Steam Pump.
1 12x7x12 Fairbanks Morris Steam Pump.
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In addition to the above we have mammoth stock of the following goods, on which we can save you money:
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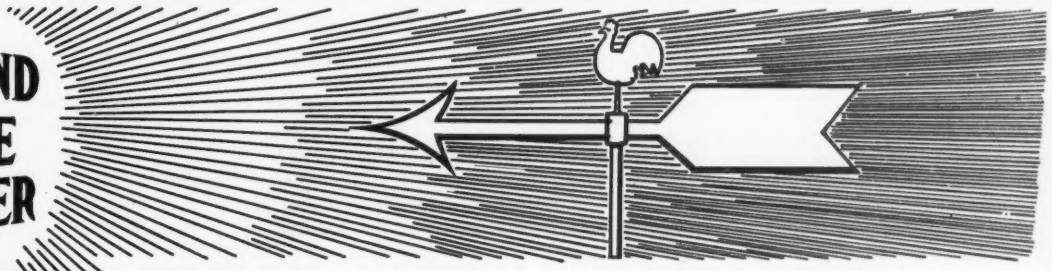
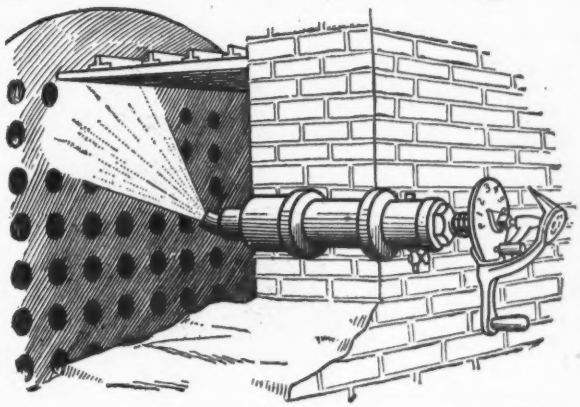


Which Way Is It Blowing?

YOUR way if you have a Diamond Flue Blower Driving the soot and dust out of your boiler flues. After a "Diamond" is installed in the rear end of your boiler setting and has begun to work, you will find that the Wind of Prosperity has turned in your direction. It will blow you reduced coal bills, reduced boiler wear and a big saving in hard work. Moreover, all soot and soot-troubles will blow up the chimney with the draft.

When our blower will do all this for *you* aren't we justified in blowing a little ourselves? Specific tests have shown that in steady service it will save as much as 10 per cent and over in fuel. The amount it will save yearly in steam hose alone will more than pay for its maintenance.



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It will stand up under pressures of 200 pounds and over, or 100% superheat. It will not scratch or score cylinder rod or shaft.

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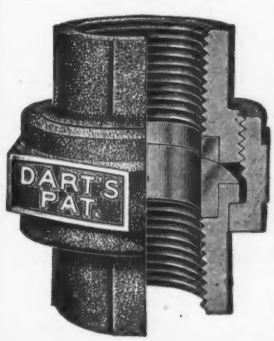

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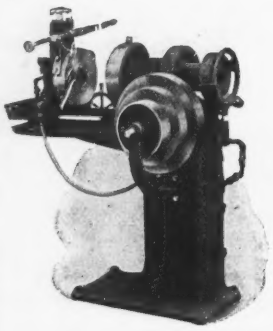

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Perhaps you can see how B. & K. Machines will save time and labor for *you.*

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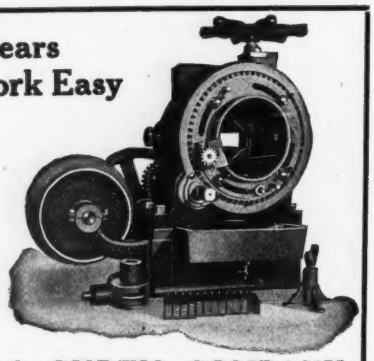

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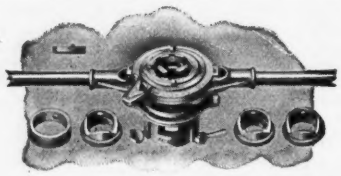

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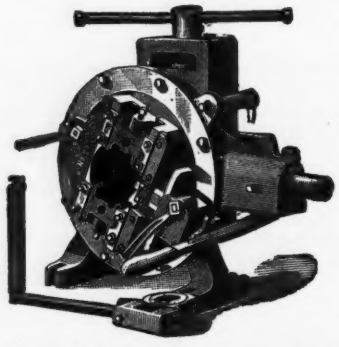

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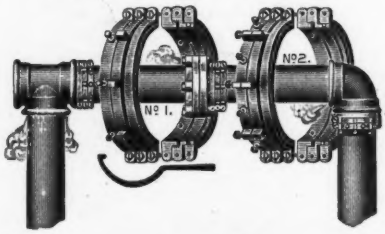

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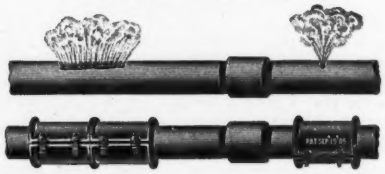

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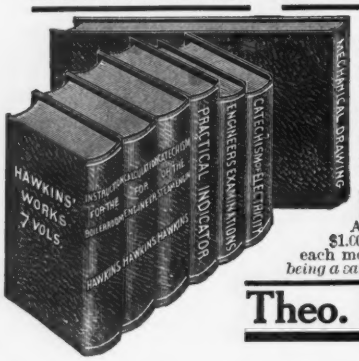

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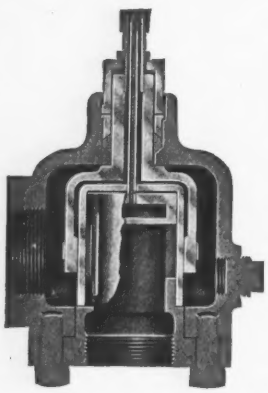

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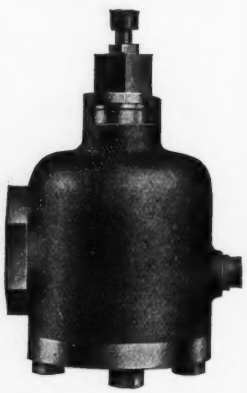

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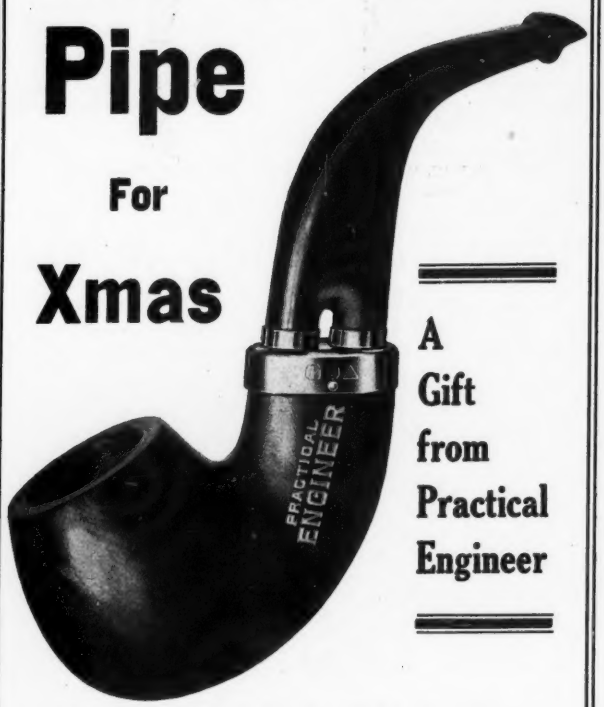

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You will enjoy this pipe thoroughly, first, because it is an unusually good pipe and, second, because it won't cost you a cent.

It has been prepared especially for us by the largest pipe maker in the country. The bowl is of selected briar, finely grained and colored—your choice of light or dark—has heavy nickeled ferrules and the stem is a single piece of hard, vulcanized rubber, perfectly bored, turned and polished.

You will notice that the mouthpiece is the famous *Wellington Protector Tip,* which sends smoke *upward* into the mouth and protects the tongue.

But the big feature of this pipe is its double-barrel draft, a nicotine-well catches all moisture and keeps the bowl dry and clean, while the long, curved smoke passage through bowl and stem gives you an absolutely cool smoke.

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Now is the time to do it!

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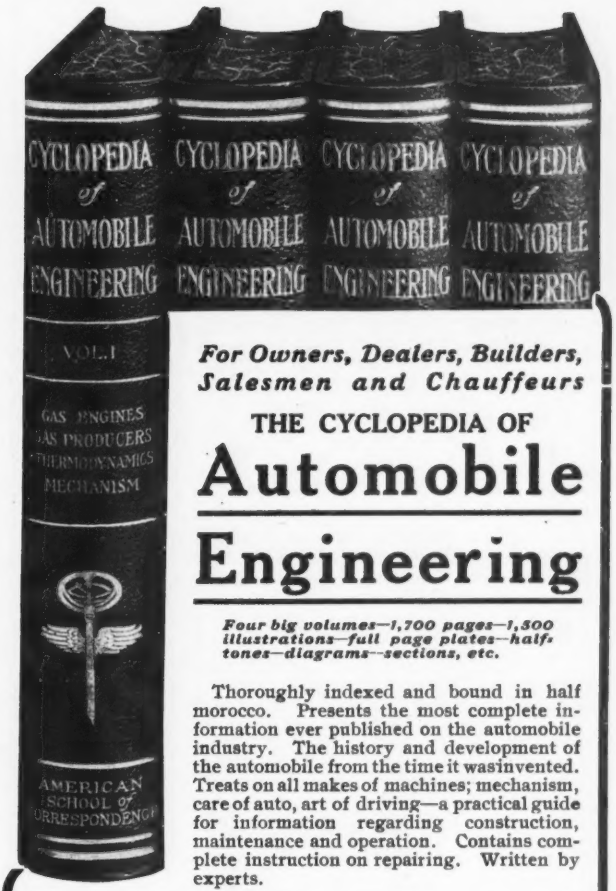

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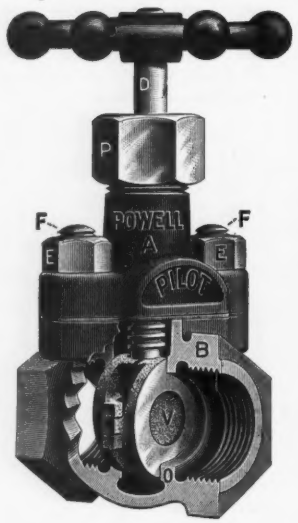

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WROUGHT STEEL BEND, WELDED OUTLETS,
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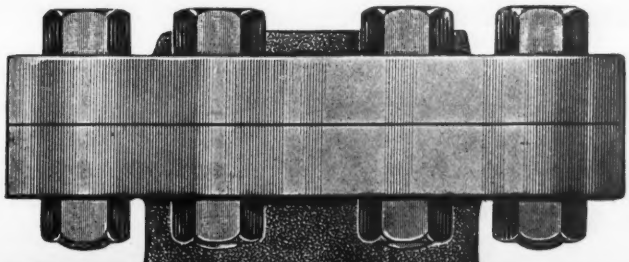

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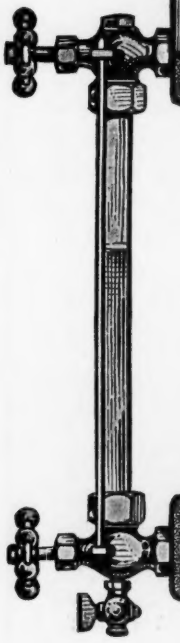
Why not avoid the issue by installing a

Cookson Steam Separator

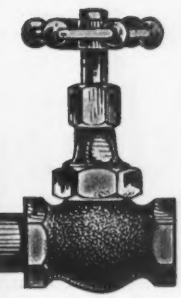


on the throttle of your engine? It will not only safe-guard your engine against accidents, but greatly increase its efficiency by furnishing a constant supply of dry steam containing less than 1% of moisture, without decreasing the pressure.

Of simple and compact construction, thoroughly efficient in operation, the Cookson Separator is bound to appeal to every engineer, because the economy and safety effected by its use will more than pay for the installation in a few months.

If your engine is without a separator, you should at once investigate and buy a Cookson.

The Williams Blue Book gives dimensions, prices and other details. We want you to have a copy. Write today.



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MAKERS OF

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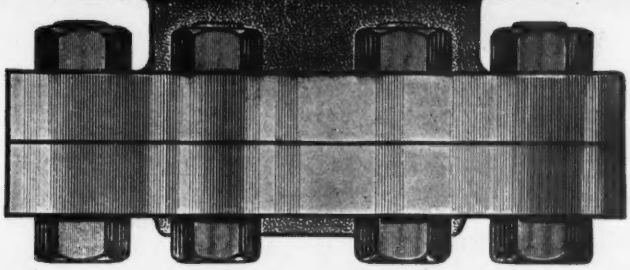

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The most important thing about an automatic regulating device of any sort is reliability under every condition imposed.

The Foster Valve reputation is for reliability.

High or low pressure regulation for steam, water, gas or air pressure, are equally easy for us, whatever it is. We have the device that suits and the size required. State your needs. *Write*

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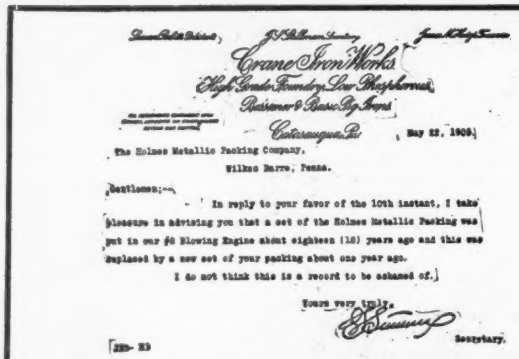

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Gentlemen:—

In reply to your favor of the 10th instant, I take pleasure in advising you that a set of the Holmes Metallic Packing was put in our 60 Blowing Engine about eighteen (18) years ago and this was replaced by a new set of your packing about one year ago.

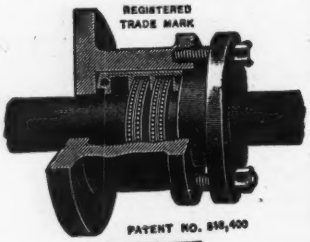
I do not think this is a record to be ashamed of.

Yours very truly,

Secretary.

HOLMES PACKING

is now recognized as being superior to all others, and is a common name among engineers.



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First cost, only cost. Guaranteed 3 years. No cutting. No friction. Less oil. Thirty days' trial.

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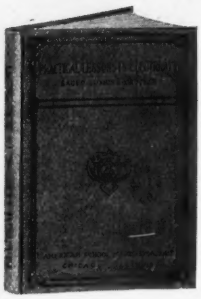

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Formerly Ass't. Examiner, U. S. Patent Office

H. C. Cushing, Jr.
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Harris C. Trow, S. B.
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Practical Lessons in Electricity is a book both for beginners and for experienced workers. It puts the prime facts of electrical knowledge so clearly and simply, and illustrates its points so copiously that any beginner can learn from it easily and rapidly. At the same time it will serve as a complete manual of information, full of suggestions of great practical value to the experienced electrical man.

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For DURABILITY and PRACTIBILITY they have no equal.

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Ask any engineer who has ever used LUNKENHEIMER "RENEWO" VALVES and if you will be guided by his advice, we feel satisfied that you will adopt them. Don't forget that they are made by THE LUNKENHEIMER COMPANY, a firm that GUARANTEES ALL OF THEIR PRODUCTS, and that while most supply houses carry them in stock, those that don't can get them for you if you simply SPECIFY and INSIST on having

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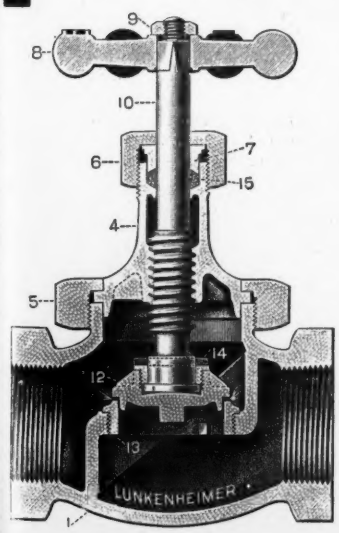

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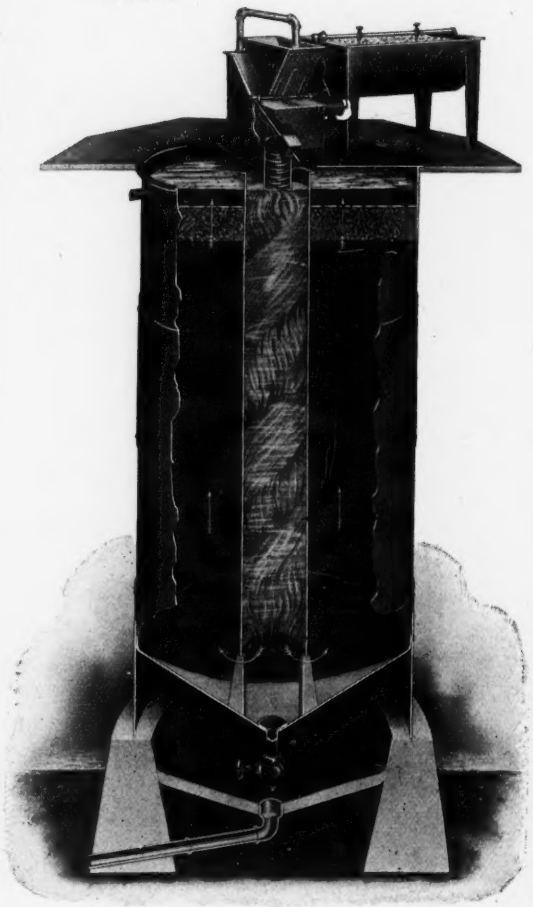
Uniform Results

Every gallon of your feed water which passes through the *National Water Softener*, will be treated just like every other gallon—ALL of it will come out reduced to the same degree of softness.



This uniformity is possible *only* because of the perfect regulation of the National system. The measurement of the water and reagents is always exactly accurate no matter how the force of the water supply may vary.

The National softener operates by gravity—entirely automatic; runs itself from morning till night without the least attention.

Its simplicity of construction, installation and operation makes it the most economical softener on the market.

We want to make a guarantee regarding your feed water. Write and let us tell you about it. Catalog also.

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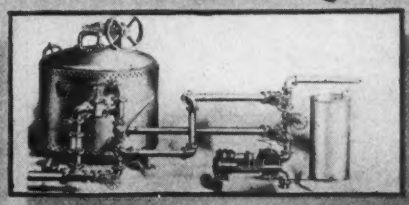
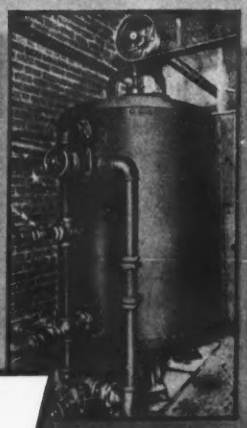

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showing their variation in size and their wonderful adaptability to fit into nooks and corners where space is limited.

No matter where it is installed, nor how unusual the conditions under which it must work,

"IT PURIFIES AT A PROFIT"

That is the secret of its popularity. Positively the cheapest to install and cheapest to maintain.

Send for catalog and book on water purification, entitled "Worth Knowing."

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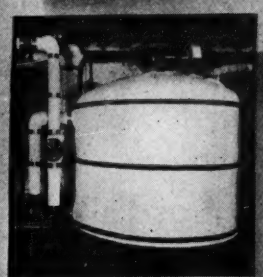

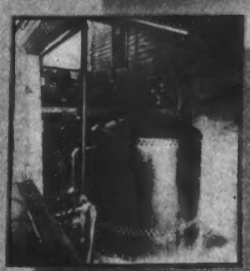
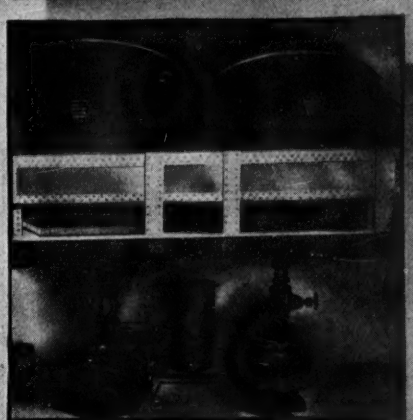
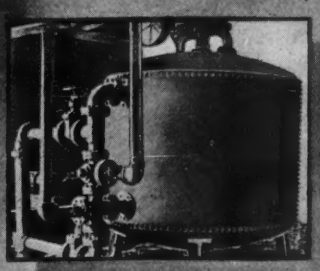
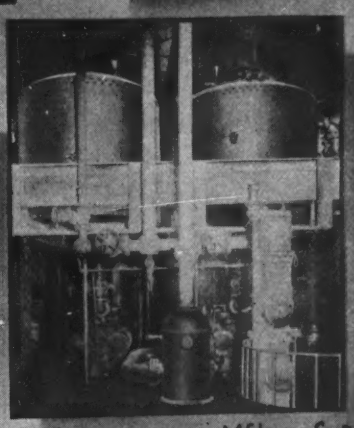

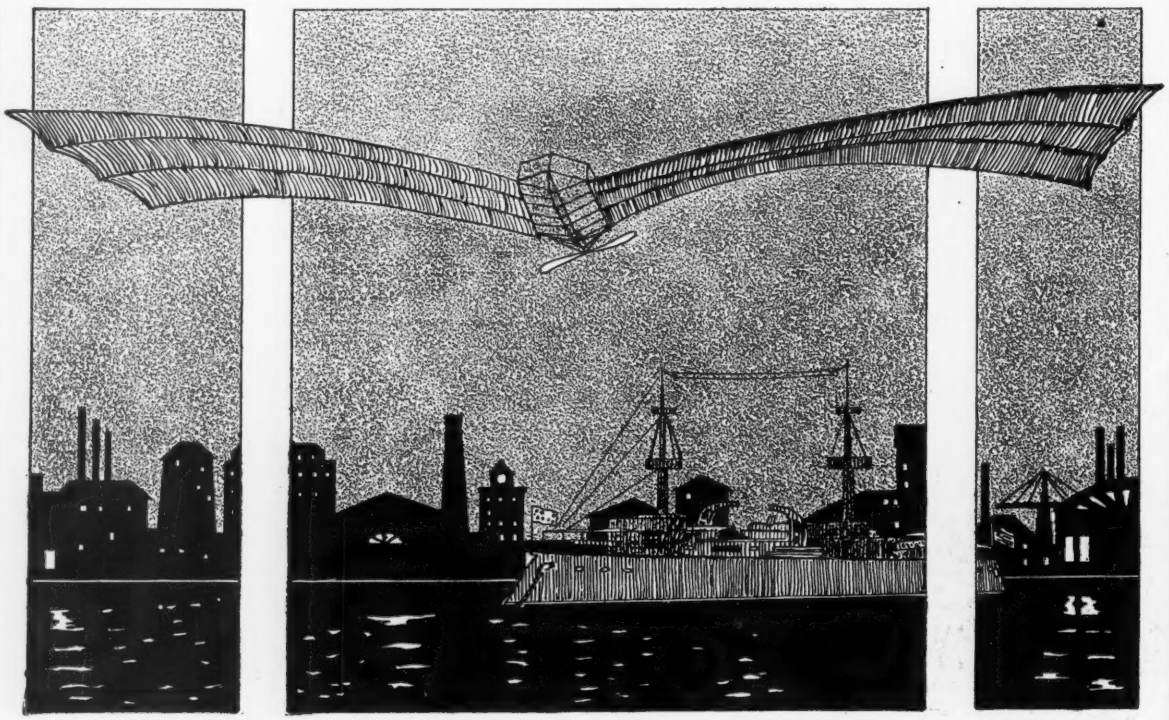

ON LAND, SEA OR AIR

Wherever water is converted into steam, or used in boilers of any kind, there

LORD'S BOILER COMPOUNDS

are necessary to complete success.

"There are many Compounds, but only one Lord's"

And This is the Reason: Lord's Compounds are made up specifically for each customer upon a carefully prepared analysis of the water actually in use. Only the best of chemicals are used, prepared and mixed by our own chemists, engineers and patented machinery. All our employees are experts in their own lines. That is why governments, the biggest power plants and all large corporations insist upon

"LORD'S"

"The kind that has given satisfaction for nearly fifty years."

GEO. W. LORD COMPANY, Philadelphia, Pa.

Actual Savings To The Boiler Owner

Effected By

DEARBORN Scientific Water Treatment

Coal consumption reduced 10 to 25 per cent.

Cost of mechanical cleaning of scale-incrusted boiler tubes—from 25 cents to one dollar per horse-power—entirely eliminated.

Boiler tubes will last much longer, and cost of frequent replacements of tubes—at $5.00 to $7.00 each—saved, as well as expense of re-rolling tubes, re-caulking seams, patching plates, and other repairs made necessary by damage due to scale formation, or injury to tubes in cleaning by mechanical processes.

All the delays and interruptions in operation of plant due to cutting boilers out for cleaning, or to imperfect service due to bad condition of boilers, with attendant losses,—prevented.

By the use of Dearborn Water Treatment, fed constantly into the boiler with the water, at an expense of but a few cents per thousand gallons of water consumed, all of these savings may be effected, and the boilers kept in perfect condition continuously, yielding their full quota of power daily.

Dearborn Science means Boiler Room Economy.

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ROBERT F. CARR, President

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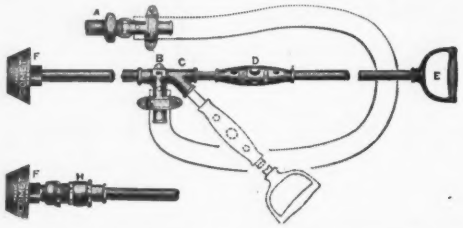
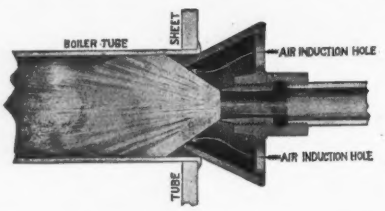
IT'S THE TREMENDOUS VELOCITY

of the AERIFIED STEAM CURRENT through the tubes that makes the "COMET" STEAM TUBE CLEANER so powerful. Attained only by the unique construction of the "COMET" HEAD. The nozzle compels rapid longitudinal expansion of steam in the direction of motion, which tends to create a strong vacuum, but is nullified by a large influx of air drawn



through the air induction holes, thereby equalizing the atmospheric pressure at both ends of tube.

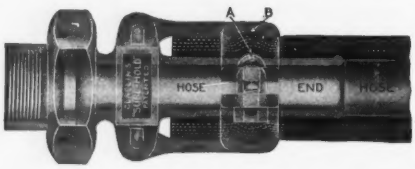
All "COMET" TUBE CLEANERS are equipped with the famous "SURE-HOLD" HOSE FITTINGS. The kind that cannot blow out at highest pressure. The all-metal construction insures great durability. The tubular handle is transposable. The eye (B) per-



mits an inexpensive attachment to counterbalance the steam hose, if desired.

The addition of the "TELESCOPE" BALANCED VALVE (H) will make the "Comet" an AUTOMATIC Tube Cleaner. These are original and exclusive features possessed only by our tube cleaners.

We don't depend upon "talking points."



No. The "COMET" HEAD does not spiral the steam throughout the tubes, neither does any other. That's an impossibility. To claim it is an imposition. The "COMET" drives the cleaning medium entirely through the tubes so rapidly that nothing but lightning can beat it. That's common sense and it does the business.

New Illustrated Catalogue?

CHAS. A. CLAFLIN & CO.,

58 High Street, Boston, Mass.

After

PYRAMID COMPOUND

has once cleaned a boiler, IT KEEPS IT CLEAN

That is one of the big advantages of a trustworthy boiler compound over *any* mechanical cleaner, no matter how good.

Scale never forms again in a cleaned boiler as long as a little Pyramid Brand Compound is added to the boiler daily.

Do you appreciate fully how much this means to *you*, to the *boiler* and to the *coal pile?*

It means a good many hours saved in hard work digging out scaled tubes, and a pile of money saved in hard cash on reduced coal bills.

Pyramid Compound is always trustworthy and always *safe*—made of purely vegetable materials which can hurt neither your boilers, piping or products.

Just wrap up a sample of your boiler scale and mail it to us for analysis. The result will be well worth your effort.

Binghamton Boiler Compound Co.

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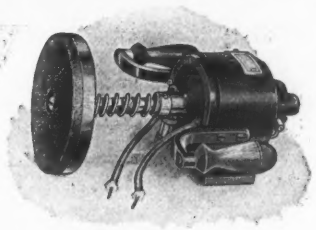
Scranton, Pa. Providence, R. I. Louisville, Ky. New Orleans, La.

Feeding Device for Stirling Boilers



Reseating Machine

Appliances You Need

Mechanical Head

Lagonda Feeding Device for Stirling Boilers

enables the operator to clean the tubes from the outside, be comfortable, do a first-class job without an assistant, and work twice as fast as if he were inside.

Lagonda Reseating Machine

cleans the faces, caps and nuts of B. & W. and similar boilers 16 *times as fast* as can be done by hand. The emery wheel is driven by either an electric, steam or air motor.

The Weinland Mechanical Head

can be belted to an electric motor or steam engine or attached to one of our special air or steam motors. In large plants, and where scale is severe, this is the most economical cleaner to operate.

The Weinland Turbine Cleaner

back of a Weinland Wing Head is best suited for ordinary boiler conditions and removes scale from tubes in the shortest possible time and with a minimum amount of water. We also make similar cleaners that can be driven by steam or compressed air.

Turbine Cleaner with Wing Head

Tube Cutter

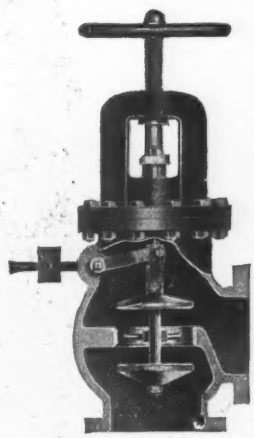
Lagonda Boiler Tube Cutter

will cut out any tube from any boiler any place in its length in short time. Suitable for different sized tubes. It saves its price several times over on one job.

Lagonda Automatic Cut-Off Valve

closes automatically and prevents injury to employes, and forestalls costly shut-downs of plant should a break occur anywhere in a boiler tube or steam line.

Any of the above appliances can be had on trial.



Automatic Cut-Off Valve

For further information write for Special Bulletins.

THE LAGONDA MFG. CO., SPRINGFIELD, OHIO

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines, and Tube Cutters

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Your wrench is here, in our Shipping-Room, all packed, ready to be sent to you—and we know you will be glad to get it.

The All-Steel Adjustable 12-Inch Pipe Wrench

is designed and constructed on a brand-new principle—the idea of a bright mechanic—whose experience with old-fashioned, cumbersome hard-to-manipulate wrenches was such as to make him dig down and get out this new design and construct the wrench for the benefit of others.

Thousands are in use and in every case their working is so quick, easy, simple and efficient as to make it marvelous. A wrench you can rely on. The illustration shows you the principle on which it works. You can see that it's a common-sense wrench—one that will grip and hold any pipe, bolt or nut, from the smallest up to 1¼ inches, no matter what the shape, size or condition may be. And it is always ready for use.

In close corners, in limited space, in over-head work and between walls or flooring, you will find that this wrench will grip and act where no ordinary adjustable wrench can even enter.

This *All-Steel* wrench is instantly adjustable to all conditions. You can pick it up—use it—and drop it again in the time it would take you to adjust one of the old style wrenches.

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Take a copy of Practical Engineer and go out among your engineer acquaintances. Find one who is not now a subscriber to Practical Engineer.

Show him your copy—tell him what *you* think of it—

Take his subscription. Send us $1.50 for one 2-years' subscription and we will send you the wrench prepaid.

Or send us $1.00 for 1-year's subscription and add 15 cents extra to cover postage.

Remember this:—

The wrench is worth getting.

Yours is waiting.

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DON'T DEPEND UPON OPEN HEATERS TO REMOVE SCALE

They will never in the world precipitate the sulphates and won't ever do away with *all* the carbonates. In fact, heat alone won't completely precipitate even the most innocent scale forming elements unless the temperature has reached about 290°, and that means a boiler pressure of 45 lbs. It also means a hard clinging scale ***inside the boiler*** instead of in the heater, unless you use

BIRD-ARCHER BOILER COMPOUND

There's no experiment about ***Bird-Archer Compounds,*** for they are made to suit individual conditions.

Send sample of your scale or feed water, and mention your average horse-power so that we can tell you the cost of Bird-Archer treatment. Ask for book "Boiler Troubles and Their Prevention."

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Practical Representatives Everywhere and More Wanted. Write.

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This trade mark is your protection against scale, corrosion, pitting and all troubles due to a bad water supply. You will find it only on

Warley's Boiler Compounds

These are chemical combinations based on scientific principles and are sold under a guarantee to do the work.

Send us a 4-ounce sample of your scale and we'll tell you what you need.

THOS. C. WARLEY & CO.,

(Established 1869)

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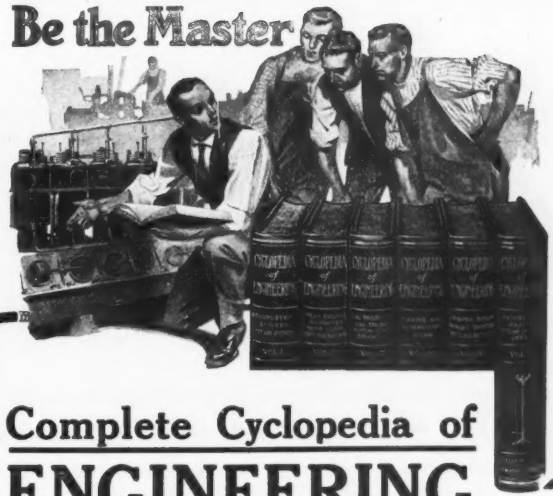

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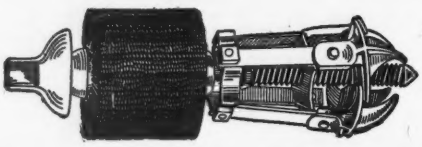

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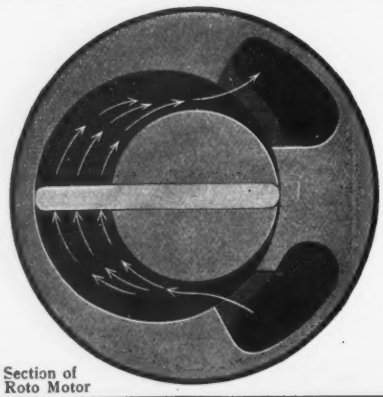

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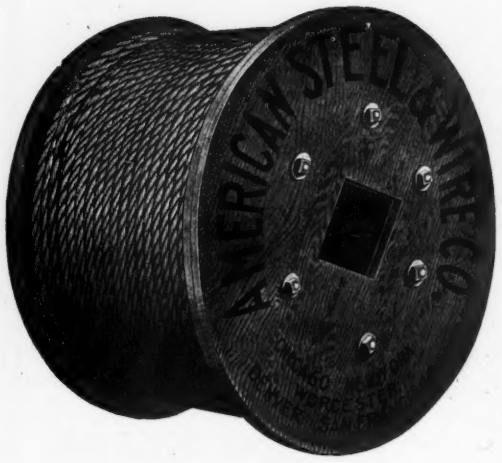

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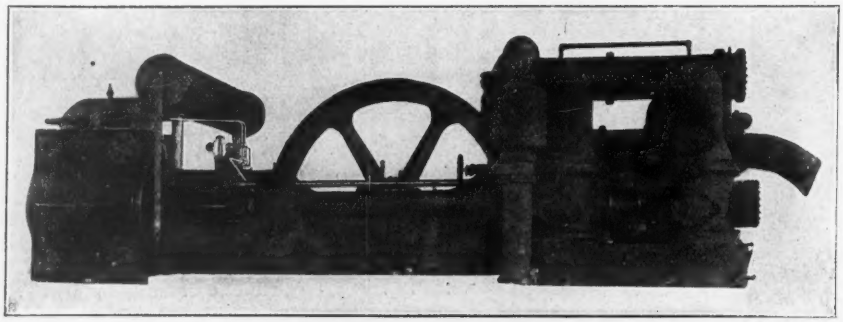

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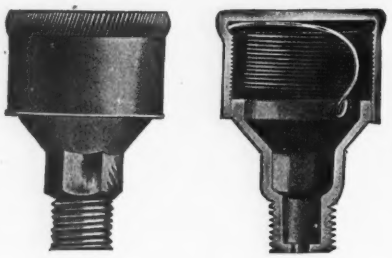

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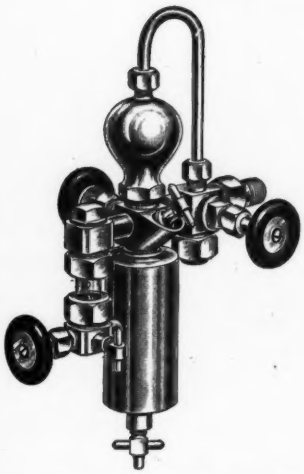

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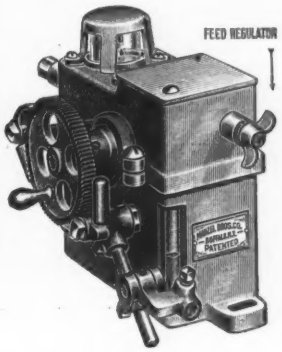

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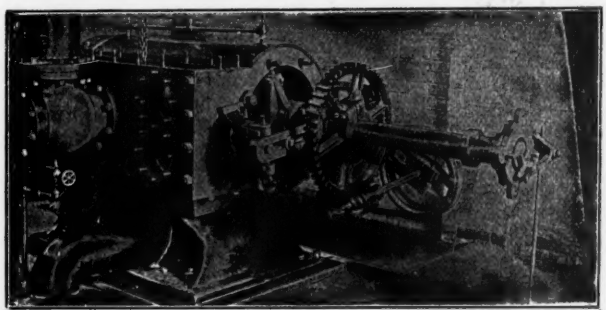

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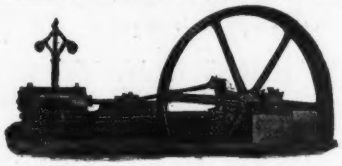

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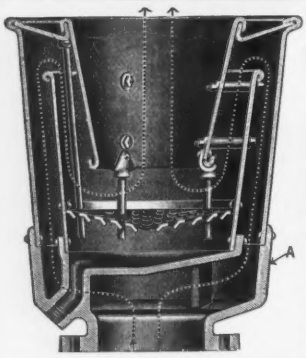

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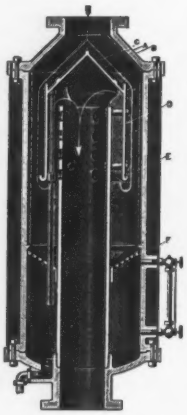

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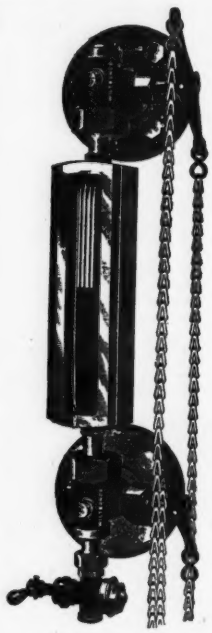

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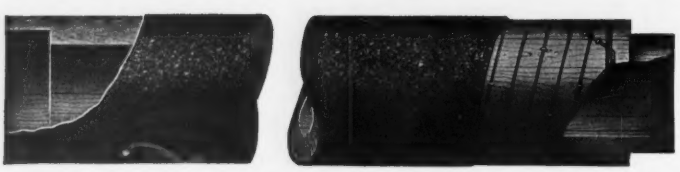

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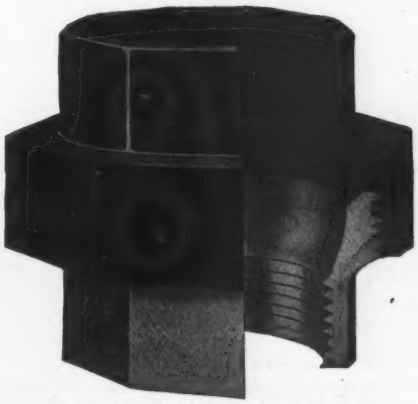

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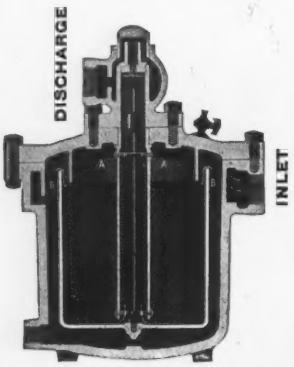

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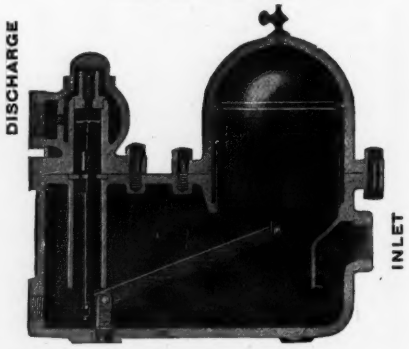

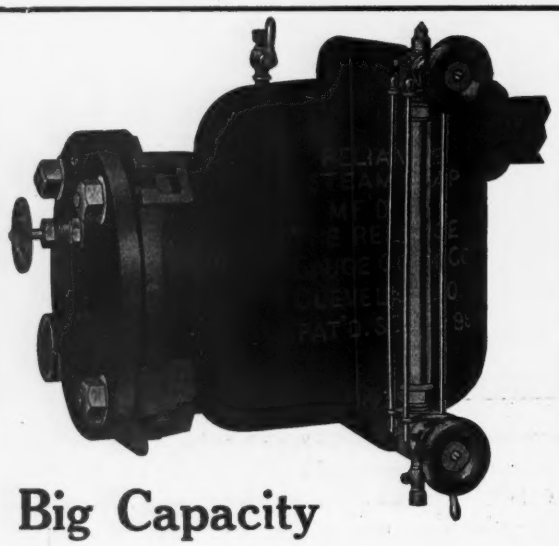

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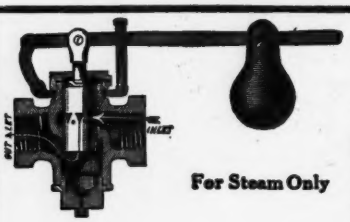

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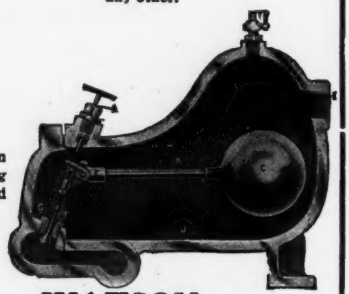

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No. 104. **Price Postpaid, $1.00.**

This indicator may be run at highest speed required, without heating. The working parts are encased. Dial has two rows of figures, reading either right or left as shaft may run.

Steel Pointed Spindle with Rubber Tips for both pointed and centered shafts. The (0) mark may be instantly set at the starting point. Send for free Catalogue No. 17-N of Fine Tools.

THE L. S. STARRETT CO., Athol, Mass.

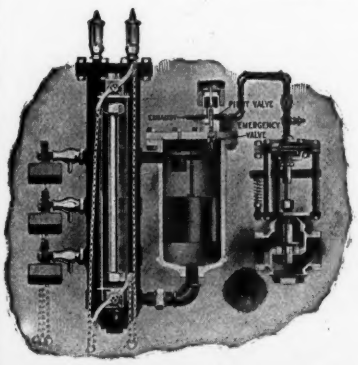
KITTS
Safety Feed Water Regulator

Assures

A constant water level in your boiler.
The greatest possible efficiency resulting from absolutely dry steam.
Minimum repair bills.

Prevents

Possible disasters from high or low water.



Also

Reducing Valves
Pump Governors
Steam Traps
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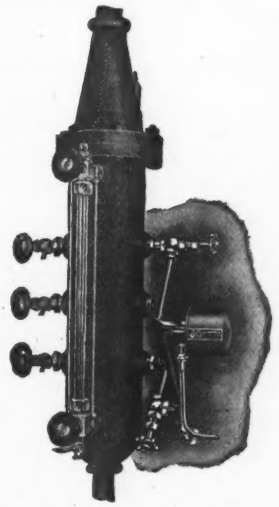
Kitts Mfg. Co.
Oswego, N. Y.

THE
"S—C"
WATER LEVEL REGULATOR



SIMPLEST CONSTRUCTION
SUREST CONTROL SMALLEST COST
WRITE FOR CATALOG
THE "S-C" REGULATOR COMPANY,
311 PERRY STREET, FOSTORIA, OHIO

The Baum Separator

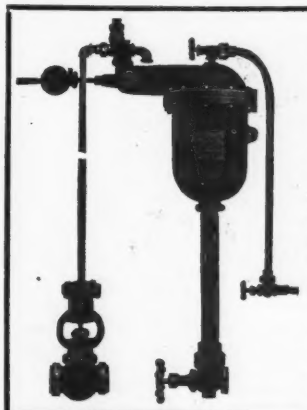
For Live Steam and Exhaust Steam—Results Guaranteed.

Repeat orders are best evidence of satisfactory results on the part of a satisfied customer.

"We are using the second Baum Separator and we are very much pleased with the results we are getting from it"—writes one who has been using Baum Separators for several years.

Write for further information before placing order. A new catalog on request.

HERSHEY MACHINE & FOUNDRY CO.,
MANHEIM, PA.
R. D. Bliss, 40 Dearborn St. Chicago



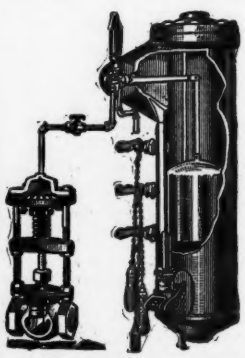
The Vigilant Feed Water Regulator

for steam boilers and the **FULTON PUMP GOVERNOR** are the best known and most extensively used. Operation simple and novel. No **floats** or diaphrams.

Send for latest catalog with list of prominent users.

The Chaplin-Fulton Mfg. Co.
Pittsburg, - - - - - Penn.

D. W. Patterson, Eastern Agent, Harrison Building, - Philadelphia



The BERRY Automatic Feed Water Regulator

Has No Internal Valves—*Write to*

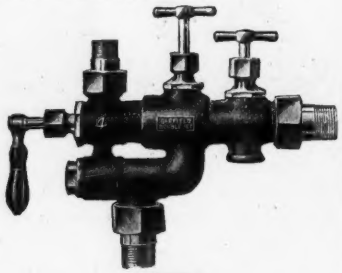
THE BERRY ENGINEERING COMPANY, - Chester, Pa.

SATISFACTION AND PERFECT SERVICE

are guaranteed when your outfit is equipped with a

CHICAGO

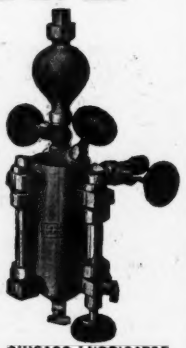
CHICAGO OR GARFIELD INJECTOR AND CHICAGO DOUBLE CONNECTION LUBRICATOR


GARFIELD

CHICAGO LUBRICATORS have the heating chamber cast into the body. This gives them over four times as much heating area as other makes which have a small brass tube for this purpose. The results are that CHICAGO LUBRICATORS feed heavier oils and will work when exposed to cold places. It will pay you to look into the merits of the CHICAGO. Ask your dealer about them, or write us for circular describing same.

We also manufacture the GARFIELD and CHICAGO INJECTORS for stationary and locomotive service. They have been adopted by over 125 of the large Railroad Companies in the U. S., and all large steam users.

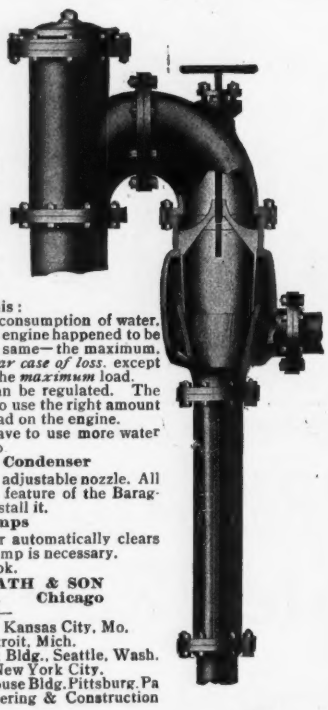
Write us for further information.


CHICAGO LUBRICATOR

THE OHIO INJECTOR COMPANY,

131 South Main St., WADSWORTH, OHIO, U. S. A.

An adjustable nozzle on a condenser SPELLS ECONOMY. The only Condenser that has an adjustable nozzle is The



The meat of the argument is this:

A fixed nozzle meant a fixed consumption of water. No matter what the load on the engine happened to be the water consumption was the same—the maximum.

On that principle it was a *clear case of loss*, except when the engine was carrying the *maximum* load.

But now the water supply can be regulated. The adjustable nozzle permits you to use the right amount of water in proportion to the load on the engine.

In other words, you do not have to use more water than you need—like you used to

The Baragwanath Condenser

is the only condenser having an adjustable nozzle. All things being equal, the nozzle feature of the Baragwanath should induce you to install it.

No Air Pumps

As the Baragwanath Condenser automatically clears itself of air and water, no air pump is necessary.

Send for the Baragwanath book.

WM. BARAGWANATH & SON
1263 W. Division St. Chicago

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W. S. Gregg, 612 Dwight Bldg., Kansas City, Mo.
F. A. Field, 26 Buhl Block Detroit, Mich.
The Corbin Co., 1112 Am. Bank Bldg., Seattle, Wash.
S. B. Whinery, 95 Liberty St., New York City.
Summit Engineering Co., 718 House Bldg. Pittsburg, Pa
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Baragwanath

No More Leaky Gauge Cocks

Under the Highest Pressures with the

SELF-CLOSING **P. B. H.** QUICK OPENING

WEIGHT GAUGE COCK

The "P. B. H." is positively the best gauge cock in the world. Thousands in use for years and not a single failure—never a leak. It is simple and positive in action, and no parts to get out of order. The ONLY renewable part is the valve pencil, which is made of SPECIALLY PREPARED METAL and lasts for years. The worn pencil can be quickly replaced by a new one costing but a few cents. A new pencil makes it a new gauge cock. The "P. B. H." gauge cock is sent on approval and guaranteed.

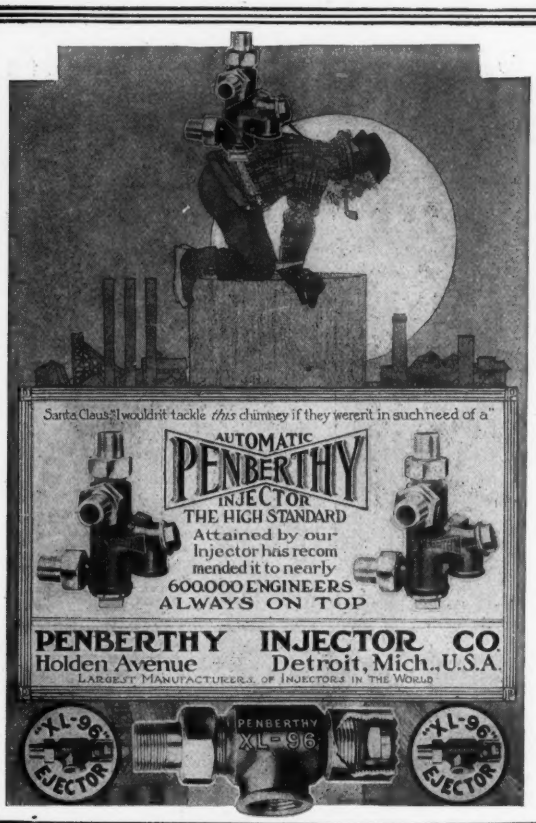
SEND FOR ONE FREE

Put it on your boiler and give it a thorough trial——if satisfactory pay us—if not, return it.

THE PAUL B. HUYETTE CO., INC.

HIGH GRADE STEAM SPECIALTIES

1245 Betz Building, PHILADELPHIA, PA.


Santa Claus: I wouldn't tackle this chimney if they weren't in such need of a"
AUTOMATIC
PENBERTHY
INJECTOR
THE HIGH STANDARD
Attained by our Injector has recommended it to nearly
600,000 ENGINEERS
ALWAYS ON TOP
PENBERTHY INJECTOR CO.
Holden Avenue Detroit, Mich., U.S.A.
LARGEST MANUFACTURERS OF INJECTORS IN THE WORLD
"XL-96" EJECTOR
PENBERTHY XL-96
"XL-96" EJECTOR

For Over Twenty-Five Years

"ST. NICHOLAS" has kept us hustling supplying him with Penberthy's, which have brought joy and happiness to over a half million engineers.

To be sure to get one, drop us a line today, and we will see that you get an injector — a "Penberthy" — that will inject new life into your plant.

Throw out your wastly and inefficient "would-be" injectors and start the new year with a Penberthy. A Penberthy Automatic Injector means steam economy, saving of fuel, sufficient to make a Penberthy Injector pay for itself in a short time. Simple and durable in construction renders it almost indestructible. It is recognized as the Standard Injector and guaranteed to make good under all conditions.

It Starts Lower, Works Higher, Handles Hotter Water and Elevates a greater distance than any other Automatic Injector on the market. It consists of only five working parts entirely interchangeable.

Write for descriptive catalog, also for the "Engineer and Fireman," an 80-page magazine, which we will gladly send free of charge to any engineer sending his name and address.

Throw Boiler Worry to the Winds

Place a U. S. Automatic Injector on your boiler and forget the trouble and worry you have suffered in the past. The U. S. Injector gives a feeling of security that you can't experience without it. The

U. S. AUTOMATIC INJECTOR

is simple, reliable and efficient; requires minimum attention, and lasts as long as the boiler it feeds—what more can you ask?

Turn the throttle and it begins feeding; jolting or jarring cannot break the constant feed. This is only one of many features which make it the supremely practical Injector for traction engines, marine and stationary boilers.

Engineers "Red Book" Free! This handy little manual is chuck full of practical information for steam boiler users. Yours for the asking—ask for it.

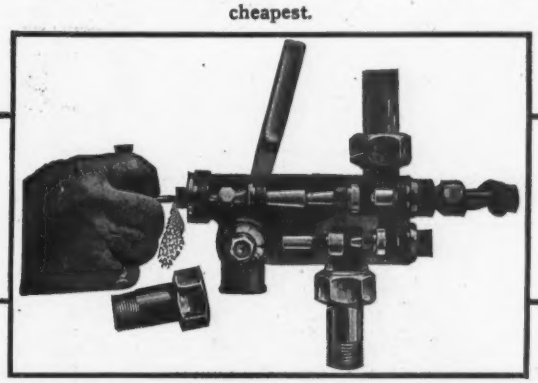
AMERICAN INJECTOR CO.,
DETROIT, MICH.

The "LEADER" Injector

Three steam specialties combined in one.
All perfect.

The Best Boiler Feeder.
The Best Liquid Scale Solvent Feeder.
The Best Syphon, Ejector or Jet Pump.

Every one a "Leader" and combined in all regular stock machines. No extra attachments required, therefore the cheapest.



Cleaned in one minute while on boiler under full steam pressure. Easily and cheaply connected. Started and stopped instantly. Always reliable. Most efficient. Satisfaction guaranteed. Heats feed water very hot. Requires no oil, no packing, no labor, no expensive repairs, no waste, no space. Drains itself.

Full particulars for the asking, from

The Randle Machinery Co., 1767 Powers St., Cincinnati, O.

Stops Waste!

If you don't keep an **exact record** of the amount of compressed air, steam or gas that is daily used in your plant you will soon find yourself at the wrong end of a hole. Cut down expense with a

St. John

Indicating and Recording

Steam, Air and Gas Meter.

It keeps a written record every minute of all that passes through it—any pressure. Our booklet contains facts of the *"show you"* kind. Ask us to send you a copy.

G. C. ST. JOHN, 90 West Street, NEW YORK.

WHAT DO YOU DO

when your feed water heater fills up with scale and grease and refuses to heat the feed water above 180 degrees or thereabouts? The constant loss of 30 degrees of heat is worth a great deal more to you than the cost of an

OTIS Feed Water Heater, Oil Separator and Purifier

which is the only heater that never fills up and which extracts the oil and grease from the exhaust.

Any heater will show results while new. The OTIS shows results all the time, because it is always clean as when new.

Note the deep separator at the bottom; no other heater has this feature and no other heater has ever equalled the OTIS in service.

Seamless drawn brass tubes that contract and expand independently of each other.

The only tubular heater with water separator, oil extractor and skimming pan.

Send for Catalog.

STEWART HEATER COMPANY
7 Norfolk Avenue, BUFFALO, N. Y.

SIMPLE—But It Does the Work

There are not many parts to it, but every part has to work. Copper coils of small diameter, rapid circulation of water, quick and constant absorbtion of heat—these are the reasons for the success of

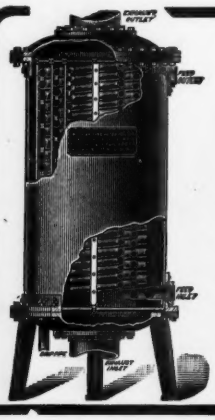
Reilly Multicoil

Feed-Water Heater

All parts easily accessible and no developing of leaks through vibration since the coils are really springs.

Fully described in our latest catalog. We'll send you a copy if you'll ask for it.

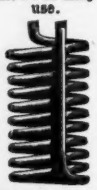
THE GRISCOM-SPENCER CO.
90 West St., New York.



The American Standard Feed Water Heater

2,600,000 H. P. in daily use.

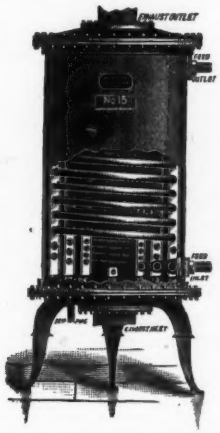
Contains coils of pure seamless drawn copper tubing. Beware of cheap imitations with brass coils. GET ONLY THE BEST. We also make all kinds of Iron, Brass or Copper Coils for all purposes.



THE WHITLOCK COIL PIPE CO.,
New York Office, Singer Bldg. Hartford, Conn.

¶ It will pay you to have a permanent exhibit of your Machinery or Mechanical Appliances in the Exhibition Dept. of **The Philadelphia Bourse.** 18,000 square feet of machinery can be shown in operation. If interested, let us send you further particulars as to Space, Rates, etc. Address

The BOURSE, ***EXHIBITION DEPT.*** **PHILADELPHIA.**



AT TOP OR BOTTOM

The exhaust steam from your engine can be admitted to the National Feed Water Heater at either top or bottom. It depends on which is the most convenient and least expensive for YOU.

National heaters are so extremely adaptable to local conditions that they meet *every* heater requirement.

Let us send you a catalog.

THE NATIONAL PIPE BENDING CO.
157 Lloyd Street, New Haven, Conn.

IN A CONDENSING PLANT

A **Cochrane** Separator in the vacuum pump line leading from a surface jet or barometric condenser or other vacuum apparatus will stop water carried over with the air. It will be more certain than an inverted loop in the air pump suction pipe and will cost less, occupy less room and have fewer joints to be kept air tight.

A **Cochrane** Vacuum Oil Separator will keep the condenser tubes clean on the outside, and the condensate free of oil, so that the latter can be used safely for boiler feeding.

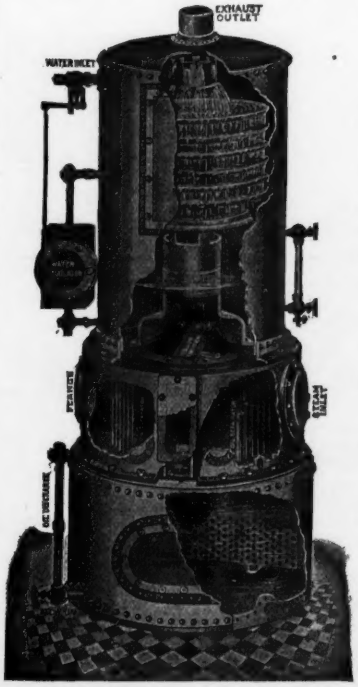
Have you insured your engines or turbines against wear and damage by installing a **Cochrane** Steam Separator in the steam line? The saving in cylinder oil, reduced friction and wear, and improved efficiency will soon pay for its installation.

Upon receipt of particulars, we shall be pleased to suggest arrangement.

HARRISON SAFETY BOILER WORKS
3144 N. 17th STREET PHILADELPHIA, PA.

100% EFFICIENCY

If You Use a Cookson Feed Water Heater in Your Plant



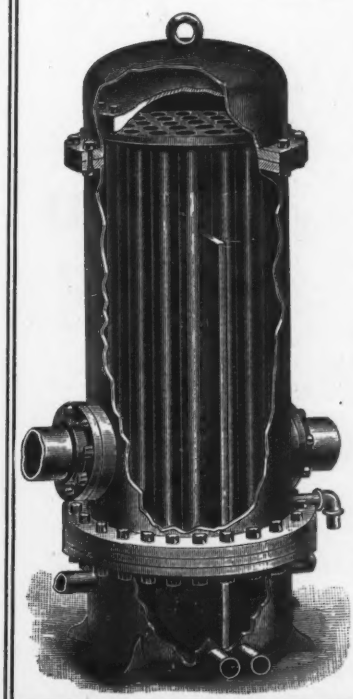
Notice the following:

1. That it is a combined Feed Water Heater, Purifier, Filter, Oil Separator and Condensation Receiver.
2. Its simplicity and thoroughly automatic features.
3. Excellent design and construction.
4. The large number of high grade fittings. No extras to buy.
5. Its manifold uses in the *one* machine—heats and purifies the water, filters it, removes all oil, and takes care of condensation returns.
6. Its accessibility for cleaning.
7. Uses exhaust steam to heat and purify the feed water—costs nothing to operate.
8. Its desirability to the user because it accomplishes more in results and savings than any other.
9. We price it so low that you cannot afford to be without it. Send for catalog; then you'll want the Heater, too.

Bates Machine Co.
Sole Manufacturers
Joliet, Ill.

Are you really getting

HOT FEED WATER NOW?



The temperature at which feed water enters your boilers makes a big difference each day in the way your coal lasts. If it enters at less than 200° to 212° you should do something about it at once.

The *Jacobs Patent Water Tube Feed Water Heater* is your best remedy. Its efficiency is positive and its cost is low. Heats water as hot as exhaust steam will heat it and creates no back pressure.

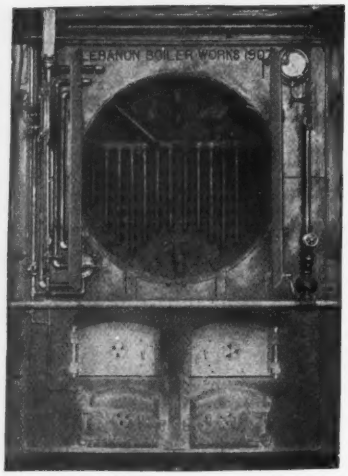
CHAS. JACOBS & CO.
49 Oliver St., BOSTON

AGENTS:

Robsmith Specialty Co., Provident Bldg., Philadelphia. D. D. Williams & Co., 623 Farmers' Bank Bldg., Pittsburg, Pa.

FIVE MINUTES WORK GIVES CLEAN FLUES ALL DAY

At the beginning or end of each day's work just five minutes use of the **AMERICAN BOILER FLUE CLEANER** will clean every flue in your boiler from end to end. It does not interfere with the operation of the boiler, disturb the fire or materially change the boiler pressure. The "American" is a permanent attachment—turning a valve is its entire operation.



The following letter will give you an idea of what it will do as a FUEL SAVER.

LOWELL M. PALMER,
78-80 Beekman St., New York.
Cooperage, Lime, Hydrating & Stone Pulverizing Plants, York, Pa.
Chas. Ekstrand, Supt.

York, Pa., April 24th, 1909.

National Flue Cleaner Co., Trenton, N. J.

Gentlemen:—I have your favor of the 23d inst., and enclosed herewith please find check as per bill rendered.

As a matter of information, we might tell you that from March 1st, 1908, to Feb. 6th, 1909, inclusive, we had 31,155.5 hours under steam and during that time we burned 944,713 pounds of coal, or 299.38 pounds of coal per hours run with 18.1% of ash. Your flue cleaner was installed on Feb. 6th and was used for the first time on Feb. 7th. From Feb. 7th to April 22d, inclusive, we had 640 hours under steam, and we burned during that time 169,129 pounds of coal, or 264.2 pounds of coal per hour's run with 15.3% of ash. We averaged 10 hours' run per day, saving in coal per hour's run 35.18 pounds. Saving per week of 60 hours, 2,110.8 pounds.

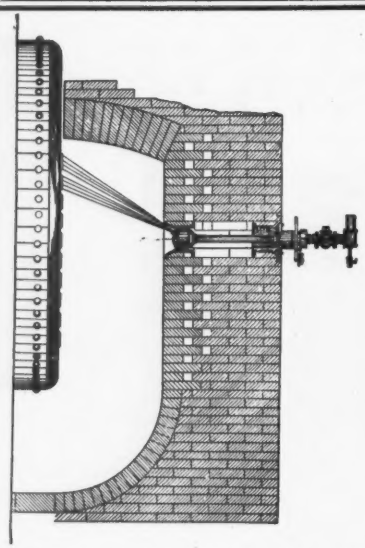
You have, therefore, complied with the guarantee which you made and hence we enclose check as stated above.

Very truly yours,
LOWELL M. PALMER,
Per Charles Ekstrand, Supt.

CE/M
Enc. Check.

You'll be interested in our Catalog—
Send for it.

NATIONAL FLUE CLEANER COMPANY, - Trenton, New Jersey
LEE T. WARD, Philadelphia Sales Manager, Bourse Building



Try it— "On Us"

We want you to know by actual experience—to see with your own eyes just how much can be saved in coal, labor, time and boiler-wear with the

Monarch Rear End Steam Flue Blower.

You can try it on *your own* boilers for 30 days. Give it a thorough test. If it doesn't do what we claim for it, return it at our expense. Write for particulars.

THE MONARCH STEAM BLOWER CO.
Corner River and State Streets, TROY, N. Y.

WANTED!

Engineers, Electricians, and Machinists to write for book, **"Mound Tools"** —free. Address Dept. E.

MOUND IMPROVED BRITISH ORIGINAL SCRAPING TOOLS
NO. 2 SET OF 6
FOR SCRAPING METAL BEARINGS, VALVES Etc
ST LOUIS MOUND TOOL & S. CO. U.S.A.

Get on our mailing list, it will be of interest to you.

MOUND TOOL & SCRAPER CO., St. Louis, Mo., U. S. A.

Erie Stoker

$350.

Can be applied to the boiler in twenty-four hours.

SAVES COAL, LABOR AND SMOKE

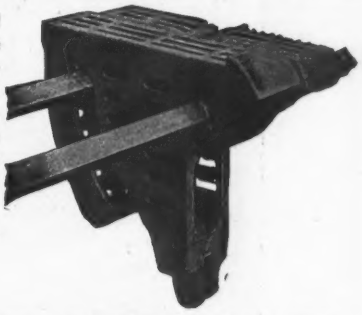
Erie Foundry Company, : : Erie, Penn.

REAGAN'S MECHANICAL STOKING DEVICE

View Showing Stoking Device in Action

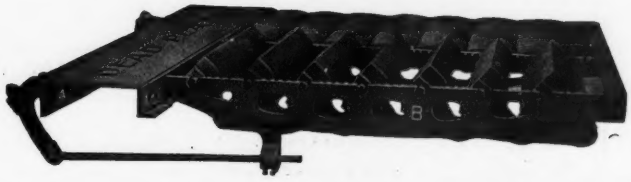
The only mechanical stoking device in the world. We guarantee that this device will do away with the use of a stoker bar, keep the fire doors shut and save both heat and coal.

Send for Descriptive Circular



REAGAN GRATE BAR CO., 211 N. Front St., PHILADELPHIA, PA.

A STRONG FRAME!



No bolts are used in putting together the frame of the Cyclone Shaking and Dumping Grate—each part interlocks into the other. Every precaution has been taken, in both design and construction, to prevent warping and there is plenty of weight and strength to stand the hardest work.

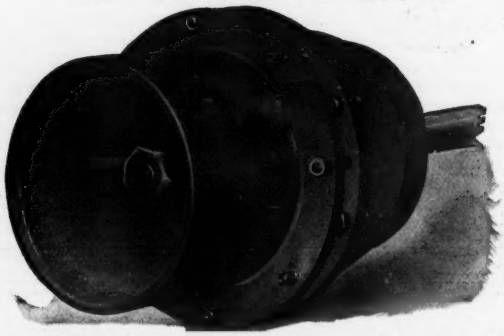
You should read our catalog. Sent on request.

CYCLONE GRATE BAR COMPANY, 827 White Bldg., BUFFALO, N. Y.

SCHILLER'S

IMPROVED PACKED PLUNGER STUFFING BOX

as applied to Elevator Pumps or any other Pumps fitted with solid plunger and ring pattern.



We will guarantee to reduce your Pump Slippage from 10% to 30%. Send for catalog, which contains testimonials from perhaps some of your friends.

Special attention given to repairing all makes of Steam Engines and Pumps. Cylinders and Valve Seats Rebored in position by special machinery. Dynamo Commutators and Crank Shaft Journals turned off without removal. Makers of Special Self-adjusting Metallic Cylinder Packing and Piston Rod Packings. Ice Machines Repaired. New Crank Pins Installed. Flat Valve Seats Faced. Builders of Special Machinery.

We will send high grade men with portable tools to attend at once to your break-down or repair work. Phone us day or night (both phones) and we will be right on the job.

SCHILLER & CO., (Reg.) Machinists and Engineers.

820 - 822 Cherry Street, Philadelphia, Pa.

REBUILT

ENGINES and BOILERS which are Rebuilt.

ENGINES.

Corliss.	Throttling.
20x48 Wheelock,	18x24 S. M. & S.
18x42 Hamilton,	16x18 Erie City,
16x42 Lane & Bodley,	14x20 Atlas,
14x36 Greenwald-Brown,	14x14 Lewis, Vertical.
12x30 Allis.	12x13 Randle,
	11x13 Randle,
Automatic Cut-off.	10x20 Fritsch,
16x32 Buckeye,	10x16 O. L. & D.
15x14 Erie City,	10x14 C. & T.
14¼x16 Buckeye,	10x12 Industrial.
13x16 Erie City,	9x12 Randle,
13½x15 Taylor,	8x12 Ajax,
12x14 Green,	8x10 Randle,
10x15 Erie City,	7x10 Randle,
8x10 Allfree.	6x 9 Randle,
	6x 8 Industrial,
Pumps.	6x 6 Randle,
All sizes, Single and Duplex.	5x 6 Randle,
	4x 6 Randle.

Most thoroughly rebuilt, highly polished, and beautifully painted. All our own, and in stock. Not scattered everywhere and merely listed. Surprising bargains in quality and condition, as well as prices.

BOILERS.

Stationary.	Fire Box.	Vertical.
72x18 High Pressure,	80 H.P.	50 H.P.
72x18 Standard,	60 H.P.	40 H.P.
72x16 Standard,	50 H.P.	35 H.P.
66x16 Standard,	40 H.P.	30 H.P.
60x20 Standard,	35 H.P.	25 H.P.
60x16 Standard,	30 H.P.	20 H.P.
54x14 Standard,	25 H.P.	16 H.P.
54x12 Standard,	20 H.P.	12 H.P.
48x16 Standard,	16 H.P.	10 H.P.
48x14 Standard,	12 H.P.	8 H.P.
44x14 Standard,	10 H.P.	6 H.P.
44x12 Standard,	8 H.P.	3 H.P.
42x10 Standard,	**Tanks.**	
36x16 Standard,	All sizes and kinds.	
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	Open and closed, all sizes.	

Saw Mill Machinery, Iron Working Tools, Etc.
Write for bargain list.
Also full assortment of new Machinery.

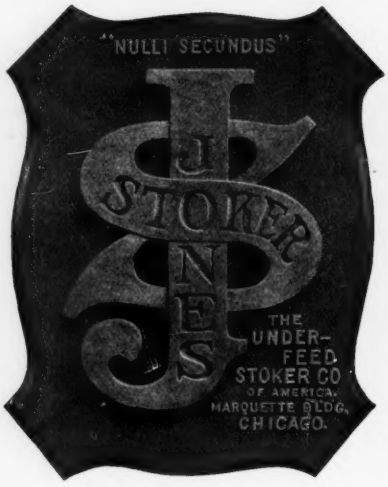
The Randle Machinery Co., 1767 Powers St., Cincinnati, O.

You can reach Economy through MURPHY FURNACES

They burn coal with the least possible waste—cheap coal and no smoke—action entirely automatic—high pressure quickly obtained and easily held.

Our Catalog will help you.

MURPHY IRON WORKS, Detroit, Mich.



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and users say *a mighty good investment, too.*

"STEEL MIXTURE"

FIRE BOX BLOCKS AND BOILER DOOR ARCH

They are easy to install, and last for years. Cracks and joints are greatly reduced. 3,000 users. Write for "Measurement Book."

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There he lived and there his body lies entombed. Besides the interest which attaches to a visit to the grave, the Illinois State Capital contains Lincoln's old home and many other places of deep interest to visitors. If your ticket reads over the

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between Chicago and St. Louis, stop-over at Springfield can be arranged without additional charge. The time tables are arranged so that passengers can spend a few hours in sightseeing en route between Chicago, St. Louis and Kansas City. Take advantage of the above suggestion offered exclusively by

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a superior quality and large variety of Bricks, Blocks and Tiles.

Write for information and prices.

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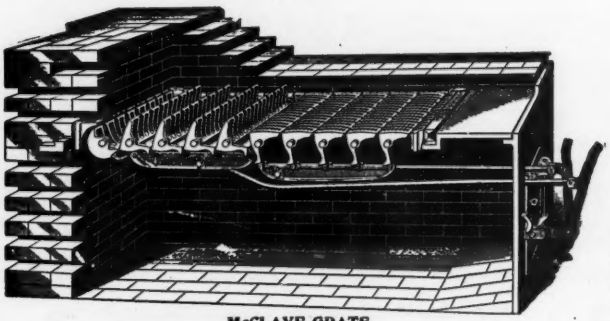


McCLAVE GRATE.
(Front half shows the Grate in its normal position.)

In Combination With

McClave's Argand Blower

Forms the most complete system for burning all kinds of anthracite and bituminous fuel, such as rice, bird's-eye, buckwheat, slack, screenings, duff, coke breeze, etc., etc., while the grate alone is unequaled for burning the large sizes of either variety of coal by natural draught. This construction will bear the closest inspection and expert investigation.

ITS USE WILL PROVE EVERY CLAIM MADE FOR IT

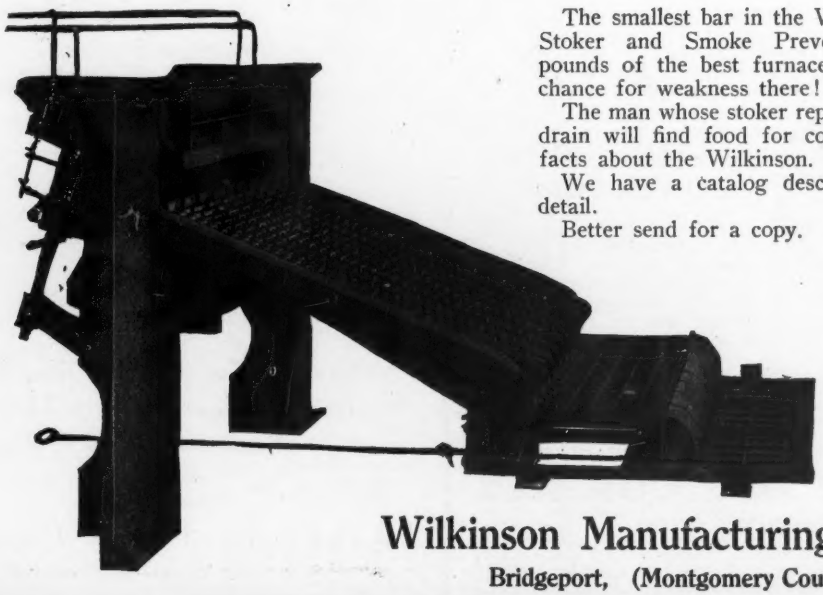
McClave's Argand Blower Furnishes a large volume of air with a small amount of steam. The air and the steam are thoroughly mixed in the shell of the blower before the blast is delivered into the ash pit. It makes very little noise in operation. For full particulars send for Illustrated Descriptive Catalog "D"

ARGAND BLOWER

McCLAVE-BROOKS CO., Scranton, Pa.

BRANCH OFFICES: { F. G. SMITH, Western Mgr., 1018 Fisher Bldg., Chicago.
CHAS. N. HAYS, Sales Agent, 1007 Empire Bldg., Pittsburg

NO GRATE IS STRONGER THAN ITS WEAKEST BAR



The smallest bar in the Wilkinson Automatic Stoker and Smoke Preventer contains 210 pounds of the best furnace metal. Not much chance for weakness there!

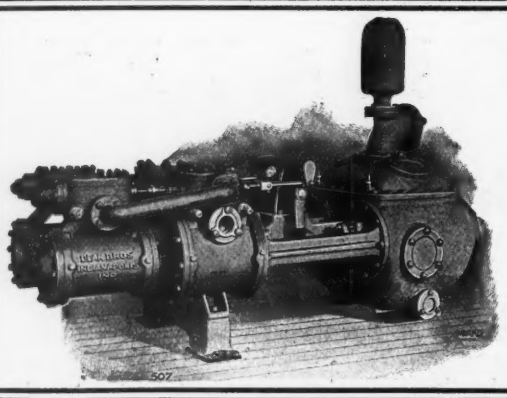
The man whose stoker repair bills are a steady drain will find food for consideration in some facts about the Wilkinson.

We have a catalog describing it in minute detail.

Better send for a copy.

Wilkinson Manufacturing Company,

Bridgeport, (Montgomery County) Pa.



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INDIANAPOLIS, IND.

DURABLE DUPLEX and SIMPLE PUMPS.

JET AND SURFACE CONDENSERS.

Hydraulic Pressure Pumps with Unbreakable Forged Cylinders.

We make the only DUPLEX Pump that will not short-stroke, valve gear without rock shafts. Perfected new patterns of both Duplex and Single types of Pumps. Vertical type of Duplex Pumps in new design. ATLANTIC type of Vertical Boiler Feeder. Write for information.

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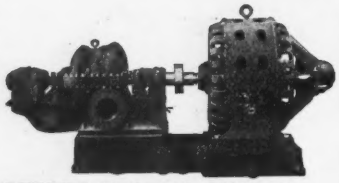

Highest efficiency
Heavy construction
Perfectly balanced
Large bearings
Horizontally split case
Interchangeable parts

MULTI-STAGE PUMPS

SEND FOR CATALOG No. 50.

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For Any Service.

DEMING PUMPS THE WORLD'S BEST

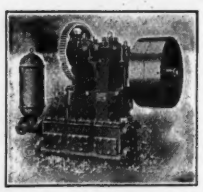

Fig. 50 For Boiler Feeding and General Service.

For Operation by any Power.

Ask for Catalog "G," and treatise "Feeding Boilers."

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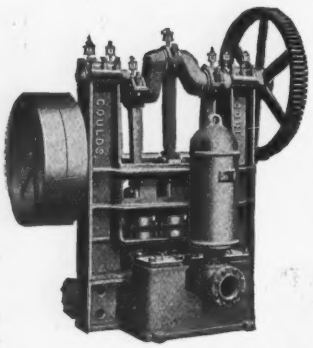
Henion & Hubbell, Chicago, Gen'l Western Agts.

OTHER AGENCIES IN PRINCIPAL CITIES.

PUMPING WATER

for use in dwellings, hotels, business blocks, etc., by means of small isolated pumps is a subject which has had a good deal of attention and study. It has brought forth a host of contrivances, but



GOULDS' TRIPLEX POWER PUMPS

when operated by gas or gasoline engines, electricity or any belt power stands pre-eminent because they are so simple and in operation so nearly automatic.

If you have any water supply problems to meet with write us for COMPLETE CATALOG 57 on the subject.

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Condensers,
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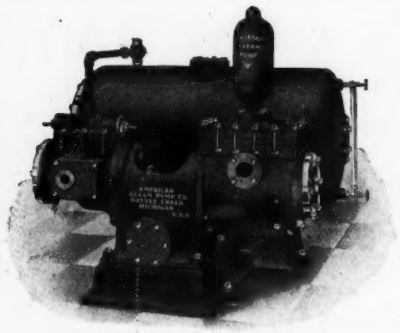


Automatic Pump and Receiver

Heating Systems

Simplex not Duplex
"To be simple is to be great"

are much more efficient when the water of condensation is handled by

Marsh Automatic Pumps and Receivers or Marsh Vacuum Pumps

Our Catalog 17 V sent on request.

Steam and Power Pumping Machinery for Every Service

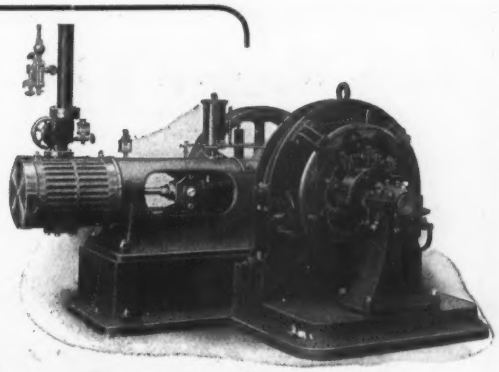
AMERICAN STEAM PUMP COMPANY, Battle Creek, Mich.

Probably You've Heard Of Ridgway Regulation

¶ The close regulation that is possible with RIDGWAY Apparatus is a big advantage to RIDGWAY users. The design of the engine governor and generator field is such that the regulation is remarkable.

¶ In service where the load is jumping from full load to no load—then back again, the voltage, with RIDGWAY Dynamos, remains practically constant. This advantage will be doubly appreciated by users where lights and elevators are operated by the same dynamo.

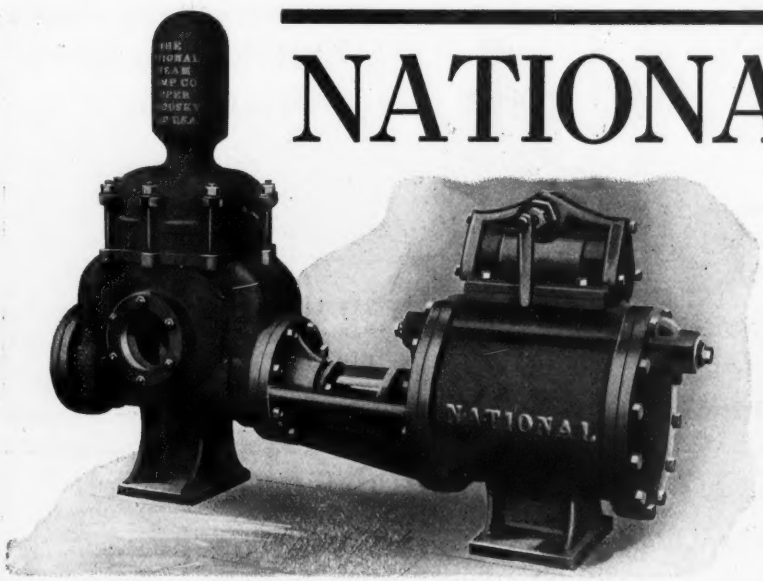
¶ Ask for RIDGWAY Bulletins, Collection P.



RIDGWAY DYNAMO & ENGINE COMPANY, Ridgway, Pa.

NATIONAL Pumps

Simplex and Duplex



PUMP TROUBLES *vanish* when you install a National.

¶ For large valve areas, properly proportioned steam parts, and a small number of working parts make National Pumps *positively* economical and durable.

¶ They are intelligently constructed. The designing machining and erection of each pump is all undertaken with a full knowledge of its future use. No guesswork about it. *Real knowledge* and *experience* is behind each one.

¶ *We make inside and outside valve gear.*

¶ Send for Catalogue 'P.'

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Upper Sandusky, Ohio

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STEAM SUPERHEATERS. MECHANICAL STOKERS.

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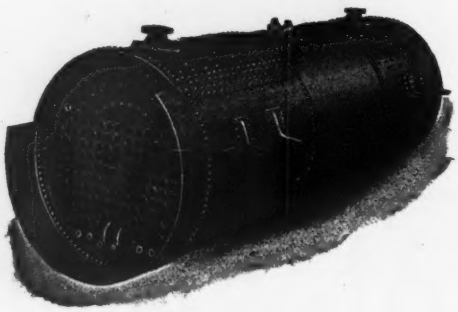

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Built complete in shop and tested before shipment.

Send for { BOILER LOGIC and SUPERHEATER LOGIC.

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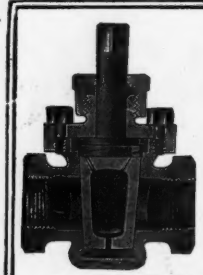

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The most important part of a valve is the seat. "HOMESTEAD" VALVES are practically indestructible because the seats are perfectly protected from wear. The plug is balanced and held in place by pressure when open, and when closed it is locked in the seat by our patent wedging cam. That's what makes HOMESTEAD VALVES outwear any other valve made. A quarter turn opens them. Fully described in our catalog, write for a copy.

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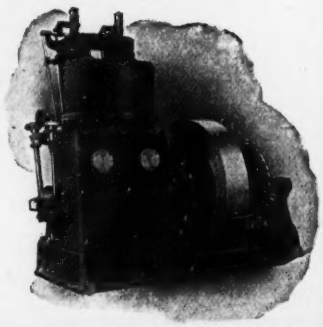
Agencies in all Principal Cities, Works at Homestead, Pa.

YOU WILL EVENTUALLY USE PRODUCER GAS

Those who have already taken the leap were generally compelled to do so because keen competition made even the power item a factor in economical operation. Let us send you letters telling of the satisfaction these pioneer installations are giving.



Builders of Automatic Scavenging Gas Engines (Jacobson's patent).
Contractors for complete Producer Gas Power Plants guaranteed by us as a unit.

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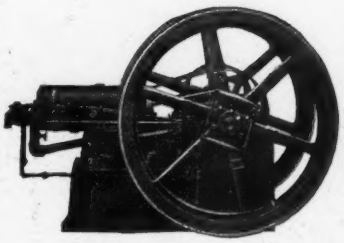
IT'S THE ENGINE, NOT THE OPERATOR

A gasoline engine should be so simple in construction and so positive in its workings that anyone can get full service out of it.

I. H. C. GASOLINE ENGINES



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Thousands of them are giving excellent satisfaction where their operators are entirely unskilled.

Why not be sure of being right on power?

I. H. C. Engines are of all styles, suited to all services, Vertical, Horizontal (Portable and Stationary) and Traction Air-cooled, Water-cooled. 1 to 25 horse power.

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are you the man that's looking for

CHEAPER MOTIVE POWER?
Begin right now to investigate the "OTTO"

Gas and Gasoline Engines. Get our catalog and compare their advantages with others. Don't depend on what we say, though, investigate what users have to say.

We'll furnish the names of those nearest to you. We have 100,000 in use in all parts of the world, all giving satisfaction, all saving money.

They're not the cheapest in first cost, but they're by far the cheapest in the long run.

If you are interested drop us a line stating your requirements and we'll send further information that will interest you.

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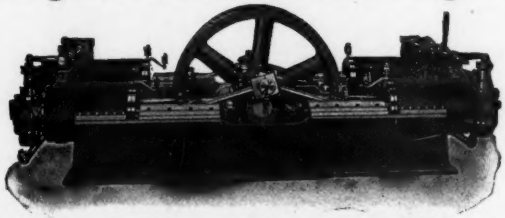

Unusually close regulation and continual economy are two important advantages of Miller Improved Gas Engines. We build them of the 4-cycle type and both direct and belt-connected. Tell us what you need—we will furnish suggestions and prices which will interest you.

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THE LYCOMING ENGINE

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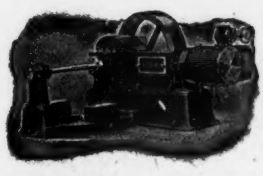

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A combination of simplicity and economy.

The largest and most complete line of high class internally oiled automatic engines on the American market.

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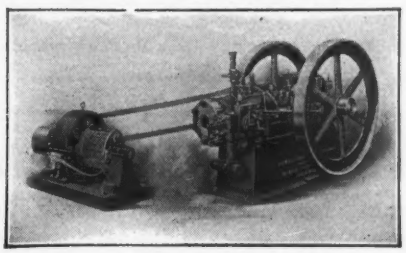
DON'T stop your gas engine every time you want to regulate the air, fuel, spark or speed.

You can adjust any of them while running if you are using



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GAS AND GASOLINE ENGINES

We guarantee 2 per cent regulation, and are prepared to prove that Du Bois Engines use less fuel in proportion to load than any other make on the market.

Write for Catalog "B," which describes our comprehensive range of types and sizes (5 to 375 H. P.), and Producer Gas Plants.

DU BOIS IRON WORKS
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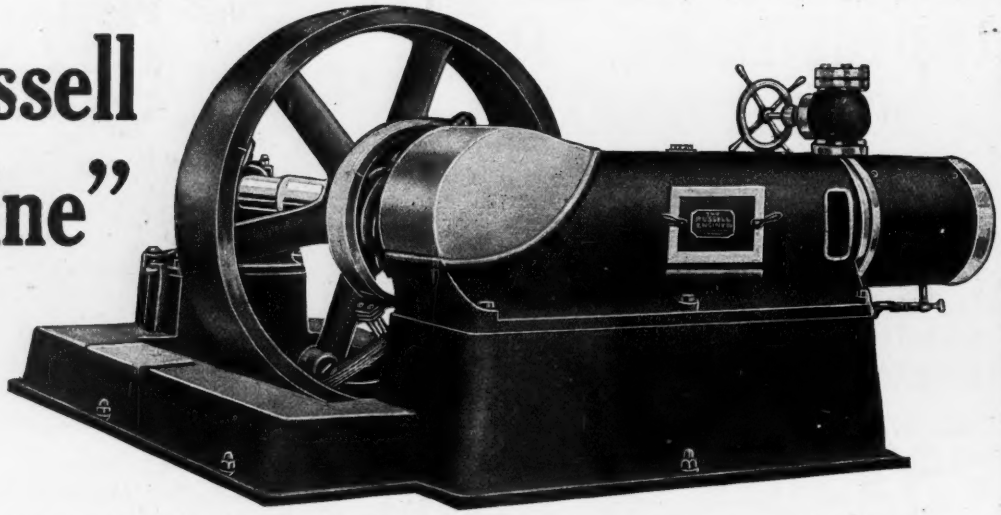
"Russell Engine"

Its use means economy



You will find the **Russell Enclosed Self-Oiling Single Valve Engine** and economical operation, inseparable. But economy is not the only point in favor of the **Russell Engine;** its simplicity, strength and rigidity are also factors that make it popular with discriminating engineers. And its reputation for smooth-running, economical steam consumption, longevity and close regulation is second to no other engine built.

Specially adapted for service in isolated plants. Write for special catalogue.

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OF THE HIGHEST CLASS

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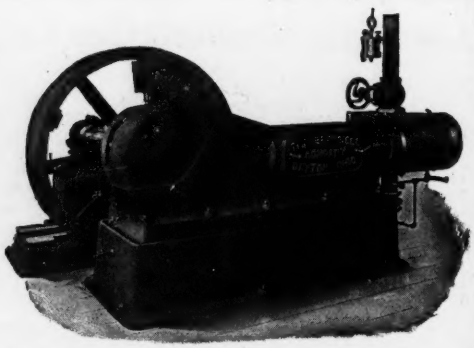

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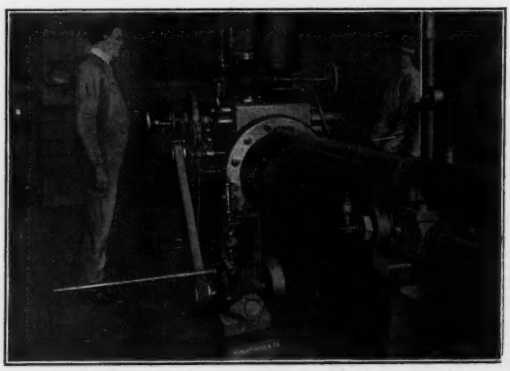
To Engines, Ice Machines and Pumps, and all machinery needs them sometime, call us. We are "Specialists on Repairs."

YOU SAVE	YOU GAIN
Time.	The benefit of our experience.
Delay.	The most satisfactory work procurable.
Shutdown.	A saving in fuel that will pay large dividends on the investment.
Having the work done twice.	



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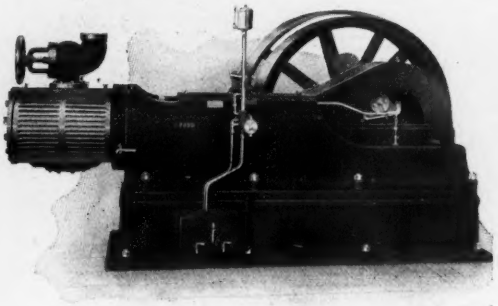

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SKINNER ENGINE CO., ERIE, PA.

Branch Offices in Twenty-One Cities

DON'T BLAME THE MACHINIST

It's not his fault that your cost of production is too high.

How can you expect him to work to any advantage when he has to stop every few minutes and adjust a lot of belts and pulleys to change the speed of his machine.

No wonder he does not turn out as much work as your competitor's machinist. Why not connect a

FORT WAYNE MOTOR

direct to his machine and increase the quality and quantity of his work.

Also remember that with line shafting and belts you are wasting about 40 per cent of your power in transmission.

Then there is floor space and the ability to locate your machines anywhere regardless of shafting.

Just figure on these points and see how long it would take the motor to pay for itself.

However, there are many makes of motors and you would be wise to send for our booklet "Motor Drives" and learn the superior points of ours before you buy.

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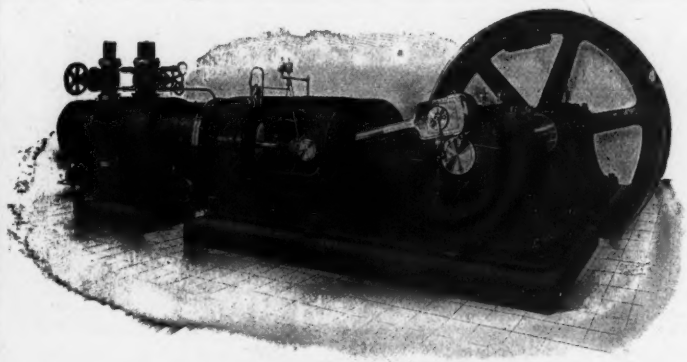

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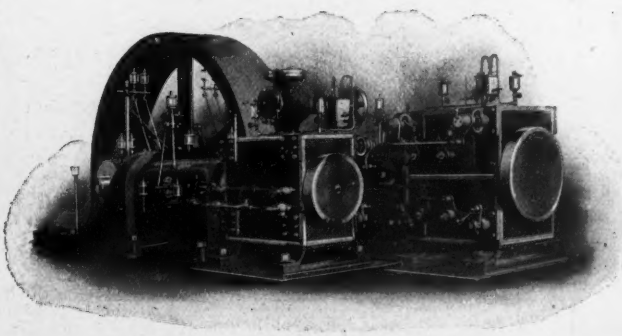

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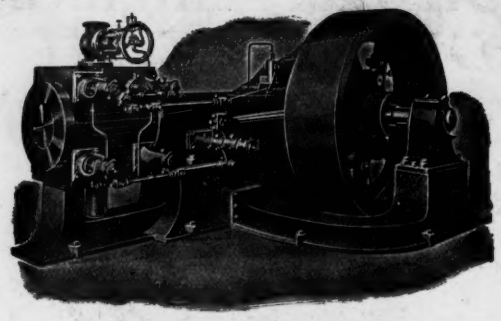

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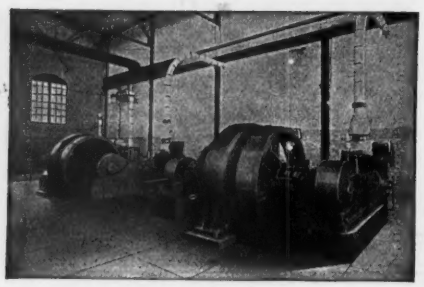

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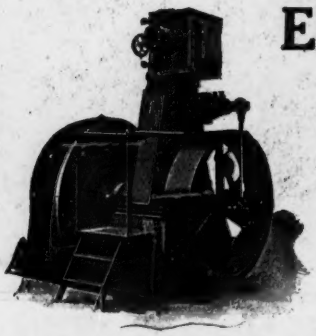

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